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[1] Seven separate drawings have been combined into a single one.

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MONTHLY WEATHER REVIEW

Editor, W. J. HUMPHREYS

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THE SIGNIFICANCE OF AIR MOVEMENTS ACROSS THE EQUATOR IN RELATION TO DEVELOPMENT AND EARLY MOVEMENT OF TROPICAL CYCLONES

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INTRODUCTION

The question of relationship between extensive air movements across the Equator and the development and early movement of tropical cyclones is considered from the standpoint of local observations on the Isthmus of Panama. Panama lies about 9° north of the Equator and is normally within the area of the northeast trades or near their southern edge during most of the year. But on comparatively rare occasions there are extensive air movements from the south that have all the characteristics of the trade winds. It is not possible from local observation alone to establish the fact that these winds are always extensions of the southeast trades of the Pacific, but this point is not necessarily important, as their direction of flow is continuous with the southeast trades and their effect on local weather is similar. All extensive air movements in this latitude can be classified as either "northerly" or "southerly" and are more or less definitely associated with the trade-wind systems of either the Northern or the Southern Hemisphere. In much the same way that "northers" and similar storms are associated with strong flows of air from the north, so also is the development of tropical cyclones in the west Caribbean associated with strong flows of air from the south. The question is: Are the winds noted in Panama what normally would be expected in the southerly quadrants of a developing cyclone, or do they possess a peculiar character of their own? In other words, are these winds more important than winds from any other direction in the processes that attend the development and early movement of Caribbean tropical cyclones?

In regard to the question as to why air movements across the Equator or winds having similar characteristics might be considered as worthy of special notice, it is desired to call attention to several points concerning tropical cyclones and the general air movements of the tropics.

Very little is known about the beginning of the destructive tropical cyclones in the Caribbean, except two things: First, a cyclonic center develops somewhere in the tropics; second, this center is transported in a direction having a positive component away from the Equator. Inasmuch as the deflective action of the earth's rotation on air movements increases with distance from the Equator, the poleward migration of the storm center is essential to its full development; and in the case of centers forming comparatively close to the Equator, is perhaps as important as the fact of original formation.

No matter what theory may be entertained regarding the details of cyclonic development, air movements of an extensive nature are necessarily involved. As it has been shown by observation that movements of tropical cyclones are controlled by the drift of the lower atmosphere surrounding them, it follows that air movements over an extensive area are associated both with their initial formation and their early movement (1). And it also follows that any atmospheric formation that fills the dual role of promoting cyclonic development and of providing the driving force necessary to carry the developing storm away from the Equator is favorable in the highest degree to the occurrence of tropical cyclones.

All air movements that may be associated with initial cyclonic development and also with the early movement of the storm fall in one of two groups; first, outflows from areas of increasing pressure; second, inflow toward an area of decreasing pressure. These two actions may appear identical to the observer, the only distinguishing characteristic being the nature of the pressure changes accompanying them.

Outflows from areas of increasing pressure are noted most frequently in the Tropics during the passage of anticyclonic areas in the Temperate Zones. The anticyclonic areas travel from west to east and usually follow a more or less pronounced barometric depression. As the general circulation of the lower atmosphere within the Tropics is from east to west, it follows that the initial overflow of air from an anticyclonic area may enter the Tropics at a considerable angle to the direction of the normal flow in this region. But as long as the air movement does not cross the Equator, its initial effectiveness as a disturbing factor tends to diminish, and, as the anticyclone travels toward the east, the direction of outflow more and more closely approaches the normal direction of the trades and eventually merges with them. But, when a strong flow of air crosses the Equator from one hemisphere to the other, its direction is changed by the deflective action of the earth's rotation, and, within reasonable time limits, it can never adjust itself to the circulation of the new hemisphere. While the normal circulation within the Tropics is from east to west, air-flows crossing the Equator tend to become more and more from west to east, and their direction to always remain at variance with that of surrounding air masses. Any storm formations that may occur, instead of being forced back toward the Equator, are carried farther away from it.

Normally, pressure conditions within the Tropics, including both the trade-wind areas and the doldrums, are very stable, in striking contrast to the Temperate Zones on either side where large pressure changes from day to day are a regular occurrence. Fundamentally the position of the doldrums and the attendant trade-wind belts are determined by the position of the heat equator. Variations normally arising within the Tropics

are of a seasonal nature only, but short period variations frequently are produced by the influence of the rapid pressure changes in the Temperate Zones. Thus the doldrums, in addition to being a region of calms, is also an area of conflict, a no-man's land of advance and retreat between opposing forces. But at any particular time, the area of the doldrums represents a condition of equilibrium between the varying impulses of the opposing trade-wind systems on each side. Normally nothing can arise within the Tropics to materially disturb this condition of equilibrium, and when a cyclonic circulation develops it commonly forms 10° or more from the Equator.

To summarize, two ways have been mentioned in which air flows across the Equator, representing a continuous flow of the trade winds of one hemisphere into the other hemisphere, may aid the development and early movement of a tropical cyclone; first, as an outflow from an area of increasing pressure such winds may function materially in the initial formation of a cyclonic center and aid its early movement toward higher latitudes; second, as an inflow toward a developing storm center they may aid its later development and influence the further movement of the storm. These two forms of action may occur singly or the first may merge into the second during the formative period of the storm.

It is intended briefly to consider available data covering periods of southerly winds at Panama with particular attention to the question of the existence or nonexistence of the theoretical forms of action outlined above, and, if such forms of action are found to exist, to consider the question of their importance in relation to the formation and early movement of tropical cyclones.

SOUTHERLY WINDS AT PANAMA

In considering periods of general southerly air movement across the Isthmus of Panama, all days with constant southerly winds and a minimum daily mean velocity of 7 miles per hour at either Balboa or Cristobal have been tabulated. Balboa is on the Pacific side of the Isthmus of Panama and Cristobal on the Atlantic side, about 32 nautical miles distant. The record covers a period of 26 years, from 1908 to 1933, inclusive. The wind record was made by a four-cup anemometer from 1908 to 1929 and a three-cup anemometer from 1930 to 1933, with velocities uncorrected. The velocities given are derived from the sum of the winds from all southerly quadrants. The number of days recorded at each station during the 26-year period follows:

Number of days with constant southerly winds at the Isthmus of Panama—26-year period, 1908–33

	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Annual
Total days at Balboa	5	19	18	4	10	47	96	24	223
Total days at Cristobal		14	23	2	11	53	88	37	228
Total days common to both stations		6	13	1	5	33	66	17	141

The record shows 223 days at Balboa, of which 82 days were at Balboa only, and 228 days at Cristobal of which 87 days were at Cristobal only. This leaves 141 days common to both stations, or an annual average of less than 6 days. The occurrence of these days is confined to the hurricane season with a lesser maximum in June and a greater maximum in October. If days common to both stations only be considered, annual totals range from none in 1911 and 1914 to 18 in 1916 and 1933. Days with southerly winds are frequently grouped in periods several days in length. During the 26 years there were 142 such periods ranging in length from 1 day at one station only to a maximum of 9 consecutive days at both stations.

The record of surface winds alone does not furnish a complete index to the conditions attending these periods. When southerly winds become established at the surface with sufficient force to overcome the land-and-sea-breeze influence, it can be stated with reasonable certainty that the entire lower atmosphere is involved to a depth of a mile or more. Surface velocities for the 223 days at Balboa averaged 11.9 miles per hour, and for the 228 days at Cristobal 9.3 miles per hour. Mean daily velocities as high as 23 miles per hour have been attained at Balboa and 19 miles per hour at Cristobal during these periods. The maximum velocities occur just above the reach of frictional influence of the surface and may at times be twice as great as surface velocities. After the winds become well established the direction at the surface is steady southwest at Cape Mala (113 nautical miles almost due south of Cristobal), south at Balboa, and southeast at Cristobal. These differences represent local influences. Above the surface the direction varies with elevation from near south to near southwest. During periods of steady winds the air is comparatively clear and rainless. The temperature and humidity are both lower than the seasonal average. A comparison of mean values of temperature and 8 a. m. dew point, in degrees Fahrenheit, for days with constant northerly winds during the hurricane season and for days with constant southerly winds follows: The days used cover a period of 10 years.

	Number of days	Cristobal (Atlantic)		Balboa (Pacific)	
		Temperature	Dew point	Temperature	Dew point
Northerly winds (Caribbean air)	104	82.9	76.5	80.9	74.1
Southerly winds (Pacific air)	75	80.0	73.2	78.4	73.2
Difference		2.9	3.3	2.5	1.9

The only significant barometer values during and preceding periods of southerly winds are relative pressure changes at two or more closely adjacent stations with accurate instruments. Absolute barometer values at one station do not constitute an index, as variations during periods are frequently exceeded at other times with no effect on local weather. The barometer values used here are daily means of bihourly values from the barograph trace checked by mercurial readings at 8 a. m. and 8 p. m. The seasonal mean barometer and values during these periods of southerly winds follow:

Barometer values during 142 periods of southerly winds

	June-November mean barometer	Average for second preceding day	Average for preceding day	Average for initial day	Low for any day	Greatest fall
Balboa	29.826	29.823	29.822	29.830	29.740	0.114
Cristobal	29.836	29.820	29.823	29.822	29.69[illegible]	.115

The barometer on the initial day is very near the seasonal mean, but the normal pressure slope of 0.010 inch toward the south is reversed to 0.008 inch toward the north. During the 19-year period, 1915 to 1933, the mercurial barometers at Balboa and Cristobal are in suffi-

ciently close agreement to allow consideration of pressure differences. During this period there is an average of 20 days each year with a pressure slope toward the north showing a pressure difference in excess of 0.010 inch. Monthly frequencies are similar to frequencies of days with southerly winds. A pressure slope of this nature is usually associated with the occurrence of southerly winds.

The reversal in the pressure slope may be produced in two ways: First, by a rising barometer in which the relative rise at Balboa is the greater; second, by a falling barometer in which the relative fall at Cristobal is the greater. The character of the pressure changes on the initial days of periods of southerly winds follows:

Character of pressure change on initial days of periods of southerly winds

	Rising	Falling	Fluctuating	Total
Short periods (with less than 2 days at both stations)	52	28	21	101
Long periods (with 2 or more days at both stations)	15	18	8	41
Total periods	67	46	29	142

In most extended periods of southerly winds the initial phase merges into what may be called the second phase. This phase is always clearly marked by a falling barometer in which the relative fall in Cristobal is considerably greater than in Balboa, indicating the development of a low-pressure area somewhere to the northward. This is the period of lowest barometer, maximum mean daily wind velocities, and steady wind direction. No matter what the distance, direction, or intensity of the low pressure area may be, the wind-flow at Panama is as steady and unchanging as that of water through a pipe. Within a few days the wind dies down, the barometer rises, and normal conditions are restored.

The nature of the air-flow during periods of southerly winds is not always clearly indicated. Sometimes it is obviously an outflow from an area of increasing pressure to the southward. At other times it is equally clear that the controlling action lies in an area of decreasing pressure to the northward. Actions of each nature are frequently combined in one period. Local observation shows that a majority of the periods are preceded by a few days of mildly fluctuating pressure changes, unequal at locations a short distance apart, during which time the normal pressure slope is reversed. Southerly winds may be initiated by either a rising or a falling barometer. Following the initial phase, most of the longer periods develop positive characteristics indicating inflow toward an area of decreasing pressure to the northward. But there are a number of outstanding periods that are unquestionably begun and controlled throughout by a steady fall in pressure in the west Caribbean, with the air-flow from the south merely a drainage toward this area.

ASSOCIATION OF SOUTHERLY WINDS AND TROPICAL CYCLONES

During the 26-year period, 1908 to 1933, 45 storms forming in the west Caribbean have been classified as tropical cyclones and so published. Thirty-five of these storms have been closely associated with periods of southerly winds at Panama, and 10 storms have not been closely so related. During the same 26-year period, there have been 142 periods of southerly winds at Panama. Thirty-nine of these periods have been associated with cyclone development, and 103 have not been so associated, although many of the latter have been accompanied by lesser storm developments. Included in the 39 periods are 4 associated with cyclone formation outside the west Caribbean but within a distance of 1,000 miles. The direct relationship in these cases is problematical although within the range of possibility. The association of cyclone formation and periods of southerly winds classified as to length and initial pressure characteristics follows:

Character of pressure change on initial day

	Rising	Falling	Fluctuating	Total
Total short periods	52	28	21	101
Number associated with cyclone formation	(6)	(8)	(2)	(16)
Total long periods	15	18	8	41
Number associated with cyclone formation	(7)	(12)	(4)	(23)
Total periods	67	46	29	142
Number associated with cyclone formation	(13)	(20)	(6)	(39)

More than half of the long periods are associated with cyclone formation but only about one-sixth of the short periods. The character of the pressure change on the initial day seems to have little significance in regard to possibility of cyclone formation, although it does furnish an index to the nature of the development.

Periods of southerly winds are associated with the initial formation and early movement of cyclones only. Many storms of east Atlantic origin have crossed the Caribbean Sea south of Cuba within the last 26 years with no effect whatever upon the air circulation at the Isthmus of Panama. But if a storm of any intensity develops in exactly the same area, it is almost sure to be associated with strong air movements at Panama. There has been one exception to this rule, the storm of November 1932, and this was really a case of redevelopment.

The association between southerly winds and cyclones seems to apply to both the initial formation and the early movement. Of the 39 periods associated with formation and movement of cyclones, 26 show southerly winds at Panama 1 or more days preceding published date of formation, and 13 show southerly winds beginning on the same day or after published date of formation. There are 14 periods of southerly winds lasting 3 days or longer at both stations that are associated with cyclone formation and movement. Among these periods, there are 3 in which southerly winds at Panama stopped with the storm center less than 500 miles distant, 7 in which the southerly winds stopped with the storm center between 500 and 1,000 miles distant, and 4 in which the southerly winds persisted after the storm center had attained a distance of 1,000 miles.

It is intended to consider in detail eight typical periods of southerly winds at Panama, using daily mean values of wind movement and pressure at Balboa and Cristobal for a 15-day period preceding, during, and following the period of southerly winds. A ninth period is also considered in which a wind record at Cape Mala is available. These periods may be classified in three types on the basis of their initial action in association with the accompanying cyclonic development; first, those periods in which the dominant feature appears to be a frontal advance from the south, and in which air-flow from the north appears to be nonexistent or to play a purely passive role in the storm development; second, those periods in which strong air-flows from both the north and the south are evident in the local record, but in which the air-flow from the south appears dominant for a short time after the initial cyclonic development; third, those periods

whose dominant feature appears to be a slowly developing low-pressure area in the west Caribbean, and the local air-flow a part of the drainage toward this low-pressure area.

Four of the nine periods considered have to be classified under the first type, whose dominant characteristic is a frontal advance from the south. All of these periods occurred during the month of October, in the years 1921, 1923, 1924, and 1926. The period in October 1910 also partakes of the same nature but will be discussed later. During October 1923 southerly winds obtained at Balboa on the 11th and again at both stations on the 16th to 19th. Following the single day at Balboa, a cyclone formed in the Gulf of Tehuantepec, about 800 miles distant, on the 13th. Following the 4-day period, a cyclone formed north of eastern Cuba, about 1,000 miles distant, on the 22d. The relationship in these cases is problematical. During the following week, from the 21st to 27th, the Isthmus of Panama experienced the heaviest general rainstorm on record.

During October 1924 there was a 6-day period of southerly winds from the 13th to the 18th. A cyclone formed in the Gulf of Honduras, about 600 miles distant, on the 16th, the fourth day of southerly winds at Panama.

During October 1926 there were 4 days of southerly winds at each station from the 15th to the 19th. A cyclone formed about 100 miles north of Cristobal on the 16th. The center of the developing storm on this date was so close as to cause variable winds and squalls at Cristobal. The Panama data in connection with this storm have been thoroughly discussed by Tingley and Hurd (2) (3). Southerly winds persisted at Cristobal until the 19th, when the storm center was about 700 miles distant.

The period of southerly winds in October 1921 has been given special attention here because an automatic wind record is available at Cape Mala, which extends the comparative wind values to three stations along a north-south line about 113 nautical miles in length. Daily mean values of wind movement, pressure, and rainfall for a 40-day period, September 25 to November 3, were examined. No general wind movement from the north is evident during this period prior to November 1. Northerly winds were purely local, due to thunderstorms and land and sea breezes. Constant southerly winds occurred at Balboa and Cristobal on 7 days at each station during the 40-day period, 1 day on September 28, 1 day on October 5, and 5 days on October 18 to 23. Constant southerly winds occurred at Cape Mala on 15 days during the same period. In general the southerly winds were associated with a rising barometer, with the relative rise in Balboa the greater. The lowest barometer occurred on October 17, followed by a general upward trend for 10 days. A tropical cyclone formed about 300 miles north of Cristobal on October 21,[1] which may be considered the fourth day of general southerly air movement across the Isthmus.

In a development like this, heavy rainfall and the highest momentary wind velocities are nearly always found in what may be termed the squall area, which may extend for a considerable distance in front of the steady winds. Most of the rainfall during this 40-day period occurred during the 10 days preceding the 20th of October. The latter part of the month was practically rainless at all stations. During the 3-day period, October 17 to 19, the Gulf of Panama represented by the Cape Mala and the Balboa stations lay in a squall area. Winds approaching gale force would blow for a short period and then die down to almost calm. The nature of the winds is suggested by the strong gale on the 19th. The wind averaged 36 miles per hour at Cape Mala for the hour ending at 10 a. m. This gale reached Balboa at noon with the wind averaging 25 miles per hour for the 2 hours ending at 2 p. m.

The steady winds became established at Balboa about midnight of the 19th and 20th, and at Cristobal during the afternoon of the 20th. The maximum wind velocity at Cristobal occurred on the afternoon of the 21st, after the storm was already in existence and under way. After these winds become well established, they are unchanging in direction. The wind at Cape Mala blew steadily from the southwest for 147 hours, at Balboa it blew from the south for 52 hours, and at Cristobal it blew from the southeast for 69 hours. After the storm developed, constant southerly winds continued to blow at Cape Mala until the 29th, but had become light and variable at Balboa and Cristobal by the 24th.

Two of the nine periods of southerly winds considered can be classified under the second type, in which strong air-flows from both the north and south are evident near the time of cyclone development. During November 1912, there were 3 days of southerly winds on the 12th to 14th. A tropical cyclone formed on the 11th about 150 miles north of Cristobal. Air-flow from the north was evident on the 10th, immediately preceding the cyclone development, and was resumed on the 17th, reaching the force of an intensified trade on the 18th, with a mean daily velocity at Cristobal of 21 miles per hour. Storms of this type usually occur near the end of the hurricane season, when the northeast trades are advancing toward the south and the southeast trades of the Pacific have not begun their seasonal retreat. Such storms usually follow a short abnormal path.

The period of southerly winds on June 28 to July 1, 1916, was immediately preceded by a moderate air-flow from the north on the 26th, represented locally at Cristobal by west and northwest winds. A cyclone formed about 150 miles northwest of Cristobal on the 29th. This is not exactly the same type as the November storms, as the northeast trades are retreating rather than advancing at this season. But the local record of barometer and wind suggests the possibility that opposing air-flows may have established close contact near the time of initial storm development. A sharp reversal of the pressure slope is centered on the 28th, marking the change in control from northerly to southerly movement.

Two of the nine periods of southerly winds considered can be classified as belonging to the third type, whose dominant feature appears to be a slowly developing low-pressure area in the west Caribbean. A 4-day period of constant southerly winds occurred on November 5 to 8, 1932. The storm associated with these winds represents the only instance in a 26-year record in which a storm of east Atlantic origin has materially influenced the air circulation at the Isthmus of Panama. This storm was first noted near the island of Guadeloupe on October 30. For 4 days it was driven in a southwesterly direction across the eastern two-thirds of the Caribbean Sea. But on November 5, after clearing the north coast of Colombia, it tapped the reservoir of the southeast trades of the Pacific across the Isthmus of Panama, and redeveloped on an immense scale, involving the winds of the entire western Caribbean and southward into the Pacific. The barometer at Panama was marked by a steady fall from November 1 to 7 and then by a steady rise until the 12th.

[1] This storm was located by Bowie on the p. m. map of October 20. See Mo. WEA. REVIEW, October 1921, vol. 49, pp. 567-569.

The mean pressure at Cristobal on November 7 was 29.694 inches, the lowest on record during any period of southerly winds.

The longest period of southerly winds ever recorded at Panama occurred on September 28 to October 6, 1933, a total of 9 consecutive days at each station. The associated local pressure record was similar to that of the storm of the preceding year, with the minimum barometer on September 30. A cyclone center was identified about 450 miles north of Cristobal on October 2.[3] This is perhaps the outstanding example of the slow development of a low-pressure area in the west Caribbean. While the winds at Balboa and Cristobal were much the same as in many other periods, reports from the southward in the Pacific at the time show no marked wind movement.

The period of southerly winds in October 1910 is of special interest in that it combines the first and third types of development under the classification here used. This is characteristic of many storms of the first type, but one type of development usually merges into the other without a break in local winds. In this case a definite break in southerly winds occurred between the original storm development on October 11 and 12, associated with a frontal advance from the south, and its redevelopment on October 16 and 17 associated with slowly falling pressure in the west Caribbean. According to Mitchell, a tropical cyclone formed about 250 miles north of Cristobal on October 11. It then moved northward to near the western end of Cuba, where it remained nearly stationary for 3 days, from the 14th to 17th, and then resumed its northward course (1). Southerly winds obtained across the Isthmus of Panama on October 12 and 13, associated with a rising barometer, with the relative rise at Balboa the greater. This was followed by a definite break in southerly winds on the 14th and 15th, and their resumption on the 16th and 17th, with a falling barometer, with the relative fall at Cristobal the greater. The storm center was about 900 miles distant at the time of the second appearance of southerly winds.

DISCUSSION

Observations of southerly winds at the Isthmus of Panama would seem to warrant the conclusion that they cover an extensive area and may be considered as continuous with the trade wind system of the Southern Hemisphere. The outstanding pressure characteristic during periods of these winds is a reversal of the normal pressure slope, indicating a change in the location of the controlling low-pressure center from south of Panama in the Pacific to north of Panama in the Caribbean. Local pressure changes show that these winds may be either outflow from an area of increasing pressure to the southward, or inflow toward an area of decreasing pressure to the northward. Action of both natures is associated with cyclone occurrence to the northward in the west Caribbean.

The constancy in direction of these winds and their distance from the attending storm center seems to show with reasonable certainty that they are not an integral part of the cyclonic circulation itself, but that they represent independent action in the general circulation. On the other hand, the fact that these winds many times precede and are closely associated with cyclone formation and movement argues that they may play an important role in the initial development of these storms. And the fact that periods of southerly winds are intensified and prolonged when accompanied by storm formations argues that the existence or movement of a cyclonic circulation in turn influences these air movements materially. The association between air movements across the Equator from one hemisphere to the other and the development and early movement of tropical cyclones as observed at Panama seems close enough to warrant the conclusion that definite relationships exist, but of such a complex nature, that without more extensive and detailed observations, the exact function and relative importance of these air movements cannot be defined.

But a number of interesting points are suggested. For one thing, it would appear that tropical cyclones may develop in a variety of ways, and, if there is any secret in the formation of these storms, it would seem to lie in unusual combinations of simple weather processes and atmospheric action, rather than in any one simple process alone. Strong air-flows across the Equator from one hemisphere to the other may be a special form of atmospheric action that plays an important role in these peculiar combinations of conditions.

One interesting feature in the action of these winds seems to be in connection with what may be termed "frontal formations." This type of action is well represented by the storm development of October 1921. Very similar characteristics are noted in connection with the "northers" of the southwest Caribbean, as distinguished from overflow northers. These storms are marked by a continuous succession of heavy wind and rain squalls, and are followed by an extended period of steady northerly winds. In this squall area are found the highest winds of the whole formation. There are no distinctive pressure characteristics. A norther may start with either a falling, stationary, or rising barometer, but there is usually a marked rise in pressure following them and accompanying the steady winds. The essential feature seems to be that the high winds and squalls occur around a slight barometric depression that must be produced in some way by mechanical action attending the frontal advance. Action of this kind may occur along a front hundreds of miles in length. A norther in the Gulf of Tehuantepec is frequently accompanied by an intensified trade in Panama or vice versa. In much the same way, when strong air movements from the south approach the Pacific coast of Panama and Central America, heavy rains and violent local storms frequently appear at widely distributed locations along the coast. Hurd (4), in discussing the cyclones of the eastern North Pacific cites instances where a cyclone may appear at one point along the Mexican coast and violent southerly gales simultaneously hundreds of miles distant.

The direction of early movement of a cyclonic development, especially when located in low latitudes, may be as important in the life history of the storm as the fact of formation itself. Cyclones forming near the Isthmus of Panama in the Caribbean move almost straight north for the first 500 miles or more of their course. If they do not, their chance of ever appearing in any published list of tropical cyclones is slight. In the southwest Caribbean, southerly gales of much the same character as those observed at Panama are the most noticeable feature of these developments. Cline (5), in his study of cyclones in the latitude of the Gulf of Mexico, shows that the highest wind velocities occur in the rear quadrants of the storm, pointing in the direction the storm is traveling. It may be difficult from observation of mature storms in high latitudes to distinguish cause and effect, but near

[3] A center was located on Oct. 1. See MO. WEA. REVIEW, October 1933, vol. 61, p. 308.

the time of formation, the early movement of the storm is most certainly determined by the action of the air masses surrounding it, and, a controlling air-flow from the direction of the Equator providing the first impulse may determine its entire future life history. Mitchell (1) has shown that tropical cyclones rarely, if ever, form in the eastern two-thirds of the Caribbean Sea. How is this fact to be interpreted? Is it because dominant air-flows from the direction of the Equator are effectively blocked by the South American continent?

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MONTHLY AND SEASONAL DISTRIBUTION OF SNOWFALL [1] IN CALIFORNIA

By MALCOLM SPRAGUE

[Weather Bureau, San Francisco, Calif., June 1934]

California, because of its great extent from north to south and its diversified physical features, is a region where the climatic elements have an exceptionally wide range. This is especially true of snowfall. On the extreme southern coast, snow has not fallen within the last 84 years, while the western slopes of the middle and northern Sierra Nevada include several localities where the annual mean snowfall approaches the record for the United States. The total fall is influenced more by altitude, proximity to the Pacific Ocean, shape and steepness of mountain slopes and their direction in relation to moisture-bearing winds, and by local topography, than by latitude. Topographical contrasts are especially noticeable in southern California, where semi-tropical fruits may be seen ripening near the bases of snow-covered mountain peaks. As an example of latitudinal influence, Imperial, near the southern border of the State, has an annual mean snowfall of 0.2 inch, while the coastal station of Crescent City (near), located some 620 miles farther north, has a mean of less than 2 inches. In contrast to this small south to north increase, modified by ocean influence, is the large increase within short distances west to east in the district adjacent to the line of the transcontinental railway which crosses the crest of the Sierra Nevada near Summit, Placer County. Within this area Colfax, elevation 2,421 feet, has an average annual snowfall of 25 inches; Blue Canyon, located 18 miles farther northeastward, elevation 4,695 feet, 203 inches; and Soda Springs, 19 miles east-northeast of Blue Canyon, elevation 6,752 feet, 410 inches.

The precipitation received in the form of snow, while consequential over only about half of the State, is a vital factor in all of the more important activities in California, providing a water reserve for navigation, mining operations, hydroelectric projects, and domestic and municipal consumption, and making possible many minor activities that depend on the others for their prosperity. The California snow-fields also have a recreational value and their use for winter sports has increased greatly during recent years.

SNOWFALL DISTRIBUTION BY MONTHS

Snow has fallen over the "High Sierra" in all months of the year, but over the valley floors and much of the coastal area, only occasionally during the winter, and spring months. Daily amounts generally are inconsequential over the lowlands and drier portions of the State, and increase with increase in seasonal precipitation and in altitude up to 7,000 feet, reaching a maximum over the western slopes of the middle Sierra Nevada. The heaviest 24-hour snowfall of record in California was 60 inches at Giant Forest, Tulare County, on January 19, 1933, and the next heaviest was 59 inches at Summit on December 23, 1916.

The distribution by months for the State as a whole in percent of average seasonal amount is as follows: January, 26; February, 20; December, 18; March, 17; April, 8; November, 7; and October and May, 2 each. The total fall for the other 4 months is less than 1 percent of the seasonal average. This average distribution is fairly representative. However, in the warmer portions of northern and central California the midwinter months

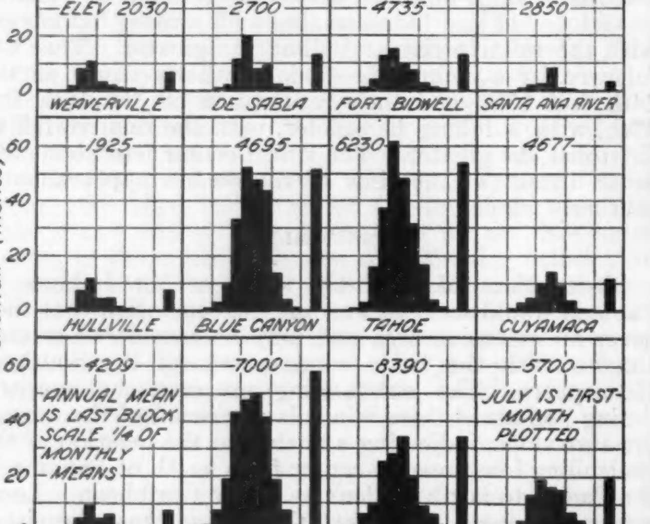

FIGURE 1.—Mean monthly snowfall distribution.

have a somewhat higher percentage than like months for the State as a whole. Similarly in the colder portions, especially over the eastern slopes of the southern Sierra Nevada, higher percentages occur in the spring months. The distribution over the southern slopes of the mountains of southern California is similar to that over the southern slopes of the southern Sierra Nevada. The monthly distribution for four groups of stations is illustrated in figure 1. Reading down from the left, the first group represents the Coast Range Mountains; the second the western, and the third the eastern, slopes of the Sierra Nevada; and the fourth, the mountains of southern California.

[1] Presented at the American Meteorological Society at Berkeley, Calif., June 21, 1934.

A longer period of record is needed to obtain representative monthly means for low-level than for high-level stations, as at the former several seasons may pass without snowfall, making it necessary in some instances to base a monthly mean on a single occurrence. Consequently monthly means for low-level stations are not comparable unless like periods of record are used, or the means adjusted. Monthly values show wide fluctuations at the moderate and high elevations also, but become more stable with increase in altitude.

The combined Summit-Norden-Soda Springs snowfall record is the longest in this State and will be used to show the range in monthly amounts for a district where conditions are relatively stable. In this area of heavy snowfall there have been years when snow did not fall from June to October, inclusive. The extremes for each month, in inches, are as follows:

	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June
Least monthly	0	0	0	0	0	6	15	3	1	T	0	0
Greatest monthly	0	T	14	89	136	245	283	207	265	298	63	19

The April maximum entered above occurred in 1880, and was exceeded at Tamarack, where the greatest monthly amount was 390 inches in January 1911.

SEASONAL DISTRIBUTION

Average seasonal amounts range from a trace or less along the middle and southern coast and in a few southern low-level, interior localities, to 449 inches at Tamarack, Alpine County, elevation 8,000 feet. About one-third of the State has an elevation of less than 1,000 feet, and the average snowfall for this third is 0.5 inch, with seasonal totals ranging from zero to 1 inch over its southern and central portions and from 1 to 8 inches over its northern portion, the maximum amount occurring in the northern Sacramento Valley. The higher the level the greater the range in the seasonal averages up to an elevation of 8,000 feet; latitude, distance from the ocean, and total seasonal precipitation are the most important modifying factors. The average seasonal snowfall is shown in figure 2 and the average seasonal precipitation in figure 3.

These charts bring out the close similarity between the seasonal distribution of snowfall and precipitation over the Sierra Nevada and the Modoc Plateau, but elsewhere a dissimilarity, which increases as the percentage of total precipitation in the form of snow decreases. The isohyets closely follow contour lines, but are more regular, probably due to lack of sufficient reporting stations to bring out all irregularities of precipitation caused by orographic control. Lines of equal snowfall follow contour lines at the higher altitudes; also at the moderate levels, except in the warmer districts. The effect of direction of mountain slopes on snowfall is the same as on the total precipitation, the westerly and the southerly receiving a much heavier snowfall than the easterly and northerly, except over very limited areas influenced by local topography. Data are insufficient to evaluate the shadow effect to the leeward of high mountain ranges. Figure 4 represents the average seasonal precipitation and average seasonal snowfall in percentages of normal for the period from 1897-98 to 1932-33, inclusive.

This graph shows that the seasonal snowfall has a greater variability than the seasonal precipitation. During the period charted, the snowfall, expressed in percent of normal, ranged from 23 in 1930-31 to 215 in 1921-22, while the seasonal precipitation range was from 49 in

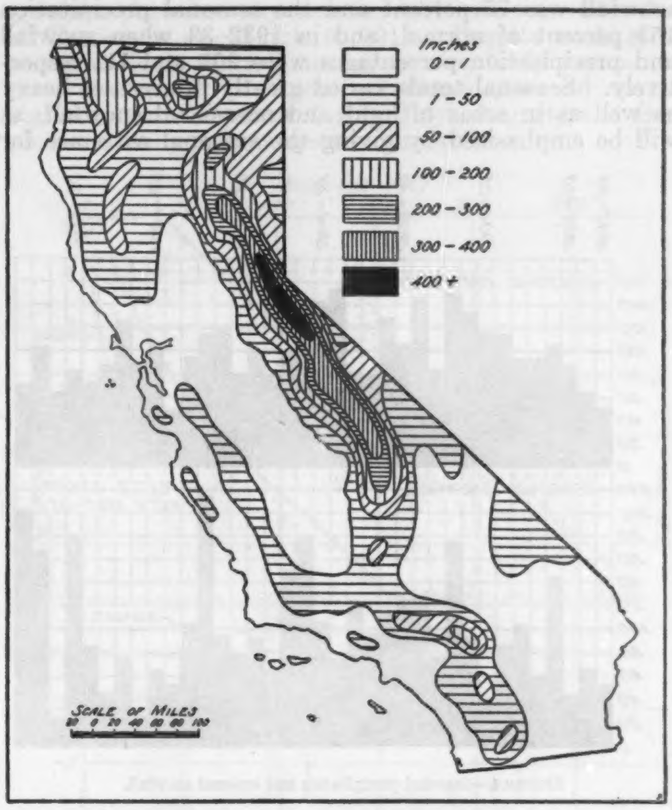

FIGURE 2.—California mean seasonal snowfall.

1923-24 to 153 in 1913-14. In general, the abnormalities of snowfall showed the same trend as those of precipitation, and in 26 of the last 37 seasons their departures from normal were in the same direction. Marked exceptions to this rule were in 1913-14 when the seasonal

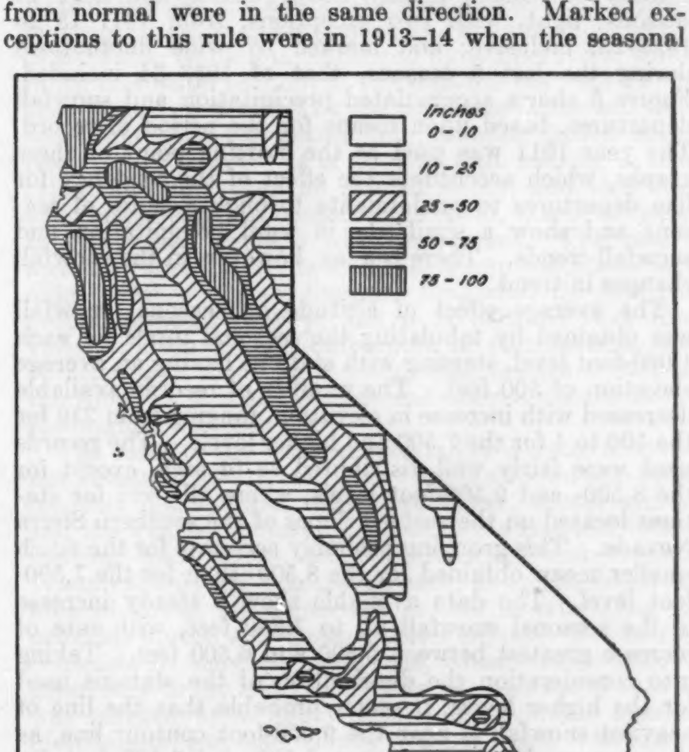

FIGURE 3.—California mean seasonal precipitation.

snowfall was 75 percent and the seasonal precipitation 153 percent of normal; and in 1932–33 when snowfall and precipitation percentages were 201 and 70, respectively. Seasonal totals varied greatly in areas of heavy as well as in areas of light and occasional snowfall, as will be emphasized by giving the seasonal extremes for

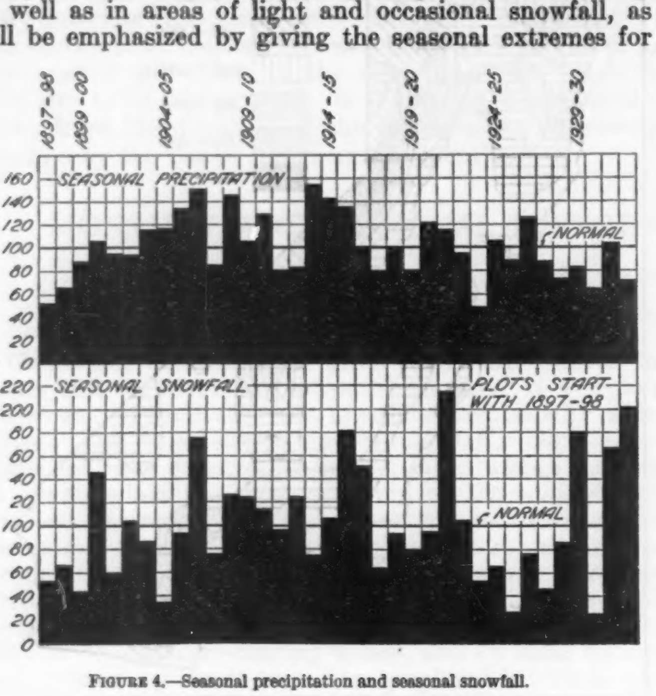

FIGURE 4.—Seasonal precipitation and seasonal snowfall.

Soda Springs and Tamarack. At Soda Springs they were 154 in 1880–81 and 783 inches in 1879–80; and at Tamarack, 266 in 1925–26 and 884 inches in 1906–07.

The snowfall was generally light during the first 9 seasons of record; mostly heavy during the next 11 seasons; light, with two exceptions, from 1917–18 to 1928–29, inclusive; and marked by wide fluctuations during the last 5 seasons, that of 1933–34 included. Figure 5 shows accumulated precipitation and snowfall departures, based upon means for the period of record. The year 1911 was used as the starting point of these graphs, which accentuate the effect of the tendency for like departures to predominate through a series of seasons and show a similarity in total precipitation and snowfall trends. There is a lag, however, in the snowfall changes in trend.

The average effect of altitude on seasonal snowfall was obtained by tabulating the seasonal totals for each 1,000-foot level, starting with stations having an average elevation of 500 feet. The number of records available decreased with increase in elevation, ranging from 239 for the 500 to 4 for the 7,500 and higher levels. The records used were fairly well distributed as to area, except for the 8,500- and 9,500-foot levels, where all were for stations located on the eastern slopes of the southern Sierra Nevada. This grouping probably accounts for the much smaller mean obtained for the 8,500- than for the 7,500-foot level. The data available show a steady increase in the seasonal snowfall up to 7,500 feet, with rate of increase greatest between 5,500 and 6,500 feet. Taking into consideration the distribution of the stations used for the higher levels, it seems probable that the line of heaviest snowfall is near the 9,000-foot contour line, as the average decrease between 8,500 and 9,500 feet for two groups of stations having similar exposure is only 0.5 inch. The rate of increase in seasonal snowfall with change in altitude for the State as a whole, based wholly on actual records available, is shown at the top of figure 6, while below are indicated the rates of increase for altitude along 5 profile lines crossing the Sierra Nevada and 1 crossing the mountains of southern California.

The rate of increase varies widely, being influenced by all of the factors that control the total fall of precipitation and snow. It is greatest along both slopes of the Sierra Nevada near an east to west line passing through Summit, and least in the desert region and near the coast. Due to orographic influence it may differ widely within short distances.

In studying the effect of temperature on the seasonal snowfall, only the mean temperature for the months of December, January, February, March, and April was used, as 81 percent of the total fall occurs during these months. It was found that, as a rule, cold winters were attended by more, and warm winters by less, than the normal snowfall. The average relationship is indicated in figure 7.

The mean curve is displaced to the right if the seasonal precipitation is above normal, and to the left if below normal; the total precipitation thus acts with the temperature in controlling snowfall departures. Expressed numerically, for the period from December to April, inclusive, 22 seasons were warmer and 17 colder than average. The average seasonal snowfall for the 22 warm seasons was 77 percent and for the 15 cold seasons was 129 percent of the normal. In only 8 seasons were mean temperature and snowfall departures alike; 4 warm seasons having had more and 4 cold seasons having had less than the usual amount. The mean winter and early spring temperature effect on the total precipitation was

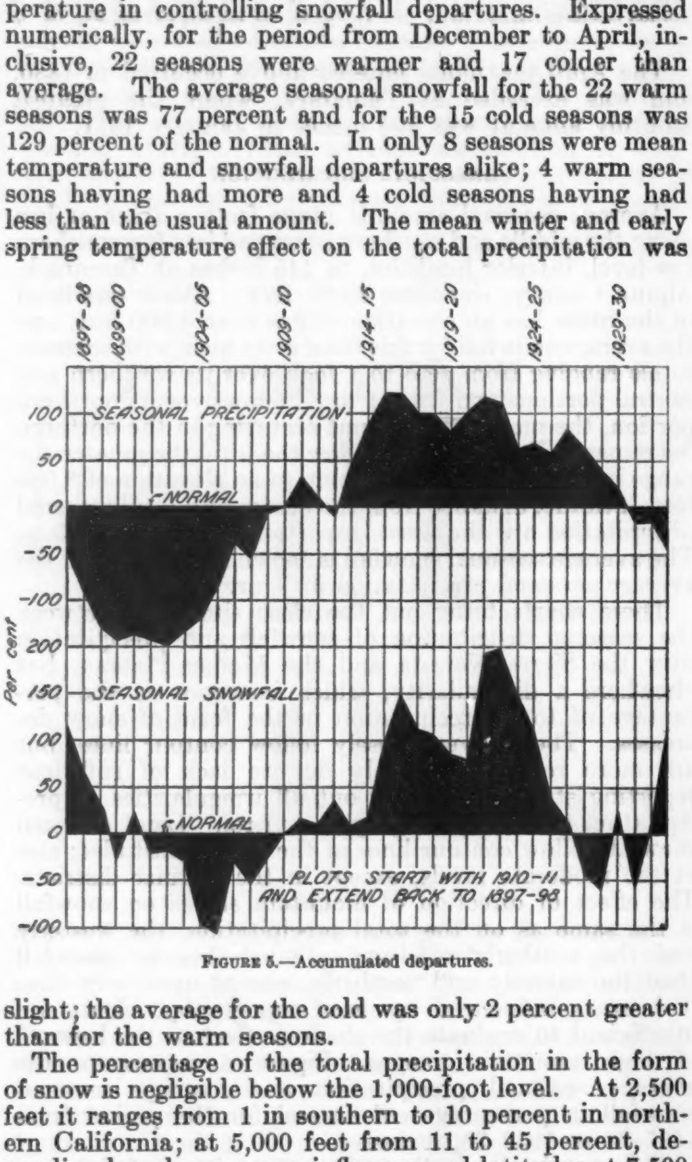

FIGURE 5.—Accumulated departures.

slight; the average for the cold was only 2 percent greater than for the warm seasons.

The percentage of the total precipitation in the form of snow is negligible below the 1,000-foot level. At 2,500 feet it ranges from 1 in southern to 10 percent in northern California; at 5,000 feet from 11 to 45 percent, depending largely on ocean influence and latitude; at 7,500 feet from 88 to 92 percent for the few stations reporting from this altitude. It is slightly less for the stations in the Owens and Mono Basins, which have an altitude of

more than 9,000 feet; the lower ratio here is due to the considerable amount of precipitation that falls as rain during summer thunder storms. The percentages given are approximations because of insufficient information as to the character of precipitation and the water content of new snow.

Efforts to measure the influence of advance of season and altitude on the water content of snowfall were also inconclusive due to lack of uniform methods and refined apparatus for obtaining the water equivalent of snowfall, many observers using the commonly adopted ratio of 10 parts of snow to 1 part of water. In general, the ratio was found to be greater in mid-winter than in spring and autumn, at high than at low altitudes, and on the eastern than on the western slopes of the Sierra Nevada, temperature of the air at time of snowfall being the prime factor. Marked variations from storm to storm and season to season were indicated by otherwise unexplained differences in the water content and rate of disappearance of the snow cover.

During the average season snow begins to accumulate at the high levels late in October, and by the end of November covers the ground above the 3,500-foot level over much of the Sierra Nevada. At the close of December the snow cover has extended downward to the 2,000-foot contour line, except near the coast and in southern California, where it is somewhat higher. The snow cover has its greatest increase in depth in January, gains but little in February, due to settling and melting; then decreases in depth, with greatest loss in April. By the close of March it has receded to the 3,500-foot level in the northern portion of the State, except in areas of unusually heavy falls; and a month later it has disappeared, except in sheltered spots, up to the 5,000-foot

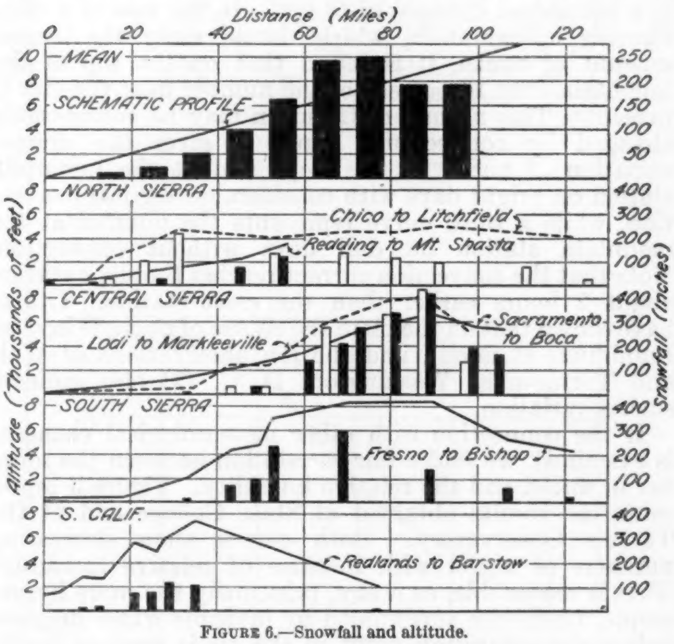

Figure 6.—Snowfall and altitude.

level in the more northern and up to 8,500 feet in the more southern districts. The deepest average cover for the State for the area above the 2,000-foot contour line is 13 inches near the close of January; but the greatest average depth for the high-level stations in areas of heavy snowfall occurs late in February or early in March; the heavier the average fall the later the occurrence of the greatest average depth. On March 15 the average depth of snow cover at Soda Springs is 106 inches, and at Tamarack 144 inches. The greatest depth of snow on the ground reported at any time in California was 454 inches at Tamarack on March 9, 1911. Despite such great accumulations, there is no region of entirely permanent snow cover; and the snow sometimes observed on the higher mountain peaks during July, August, and September usually is from recent storms.

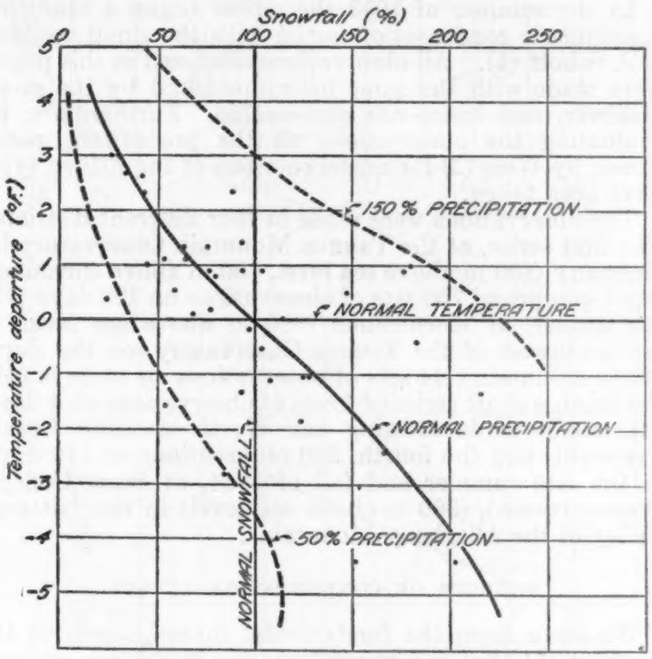

Figure 7.—Temperature-snowfall-precipitation relations.

The accumulated snow diminishes in area and depth by melting, settling, evaporation, and ground absorption. Rate of melting and evaporation accelerates with increase in temperature, wind movement, and amount and intensity of sunshine; settling is influenced by temperature, winter rains, and water content of the seasonal fall; and ground absorption is controlled by the condition of the soil when snow first begins to accumulate, whether frozen or unfrozen, wet or dry. It is obvious that melting is more rapid on sunny than on shaded slopes, and that deep and shaded canyons conserve the cover, unless subjected to more than average wind movement. The rate of melting varies greatly in localities where conditions seem alike, patches of snow lingering long after the first bare ground appears nearby; and it is believed that these variations are due to differences in composition, temperature, and moisture of the ground surface underlying the snow, as well as to shade and uneven distribution of the original snowfall.

The value of the seasonal snowfall as a water reserve is not measured by total fall alone, but is affected also by the monthly distribution, water equivalent, winter rainfall, and the weather factors that modify the rate and time of melting and cause alternate thawing and freezing. Water content and firmness of pack, as well as depth and area of cover, are important factors in estimating the probable spring and summer water supply. For marked contrasts in snowfall conditions, consideration need be given only to the last two seasons: The season of 1932–33 was marked by a heavy total fall, favorable monthly distribution, and cold, cloudy weather which retarded the melting of snow and ice; while the present season had a light fall, which came too early for best results, and after the first of January much warm, sunshiny weather, which caused the snow cover to disappear earlier than during seasons when the total snowfall was less.

OBSERVATIONS OF CONDENSATION-NUCLEI IN THE ATMOSPHERE

By H. LANDSBERG

[Geophysical Laboratory, Pennsylvania State College, State College, Pa., December 1934]

OBSERVATIONS

In the summer of 1933 the writer began a study of atmospheric condensation-nuclei with the small counter of J. Scholz (**1**). All observations discussed in this paper were made with the same instrument and by the same observer, and hence are comparable. Furthermore, in evaluating the observations all the precautions mentioned by Wait (**2**) for nuclei counters of the Aitken type have been taken.

The observations were made in four different districts: The first series, at the Taunus Mountain Observatory in Germany (800 m above sea level, 700 m above surroundings), comprised 700 sets of observations on 120 days (**3**); the second, at Koenigstein (500 m above sea level, 4 km southwest of the Taunus Observatory, on the slope of the mountain), 44 sets of observations on 10 days (**4**); the third, a short series of 7 sets of observations on 4 days (**3**), made while crossing the North Atlantic Ocean westward; and the fourth, 300 observations on 110 days in the late summer and fall of 1934, at State College (Pennsylvania), (360 m above sea level) in the Nittany Valley of the Allegheny Mountains.

SOURCES OF CONDENSATION-NUCLEI

We know from the fundamental investigations of H. Koehler (**5**) that many condensation-nuclei are sodium chloride crystals from the oceans. The amount of chlorine in rain water indicates that practically all condensation-nuclei in the higher levels of the atmosphere must be salt crystals, otherwise it would be very hard to account for the amount of chlorine in fog and rain water found by H. Kohler and recently also by H. Israel (**6**) and M. Bossolasco (**7**). Nevertheless the number of condensation-nuclei coming from the ocean is astonishingly small. Wigand, Bossolasco, and others stated this fact; and my observations on the North Atlantic Ocean show an average value of 950 No/ccm, with a maximum of 1,450 No/ccm, and minimum of only 150 No/ccm. These values are for the layer nearest the surface of the sea. As the number of nuclei decreases rather rapidly with altitude, even in case of considerable convection, and as it decreases probably also with distance from the ocean, and since we have, on the other hand, about 200 droplets/ccm in clouds, it is very difficult to account for all the nuclei necessary by salt crystals from the ocean. However, to account for the amount of chlorine in rain water we must either assume that the nuclei are larger by far than heretofore assumed (10^{-15}g), or that other sources of chlorine are present. This problem requires further investigation.

In settled countries by far the largest number of condensation-nuclei are due to combustion. Practically all products of combustion which occur in atmospheric suspension, except perhaps, only the larger soot particles, are condensation-nuclei. Factories, railways, house furnaces, and, by no means least, the combustion gases of motor cars, furnish the vast amount of condensation-nuclei which we find in the cities. This is clearly shown by the annual variation of the number of condensation-nuclei in or near populated districts. It is even to be seen in a small countryside town, such as State College, Pa. Figure 1 shows that the condensation-nuclei nearly doubled after the heating period started this fall, 1934. The same observation recently has been published by Egloff (**8**) for Davos. The ion countings of Wait and Torreson (**9**) at Washington, D. C., also show the same tendency. Clearly, then, the number of condensation-nuclei in settled regions gives us a fair picture of the suspended impurities in the air.

The third source of nuclei is the ultraviolet radiation of the sun, which forms large ions. We found as many as 500,000 No./ccm due to such ions near a mercury lamp, in agreement with L. Schulz (**10**). Although these are laboratory values it may be assumed that also in the free atmosphere a certain number of nuclei are due to ultraviolet solar radiation. This may be one reason for the variations of nuclei in unpopulated regions (cf. Hogg, **11**).

THE VARIATIONS OF NUCLEI

In the regions here under consideration, however, this last possibility may be neglected, as there are in these places far more potent factors. The largest local variation is due to the elevation. Wigand (**12**) has measured the distribution of nuclei with height by balloon ascents; but it is also possible to get very good results for the lower levels by motoring from a plain up to the top of a nearby mountain. This has been done several times by going from the top of the Taunus Mountain down to the industrial centers in the Main Valley near Frankfurt (Germany), which covers a difference of 700 m in height in a horizontal distance of 18 km. In the case of a wind blowing up-mountain, which should carry the largest amount of nuclei, it is found that on the top of the mountain only 10 percent of the number near the city is present. This normal distribution may be considerably changed by convection. Figure 2 gives the diurnal variation of nuclei on the slope and at the mountain station on bright days with considerable vertical convection, while a third curve represents the number at the mountain station on dull days without convection. Note that the convection current reaches the slope station about 2 hours earlier than the crest station. Others have shown that on the plain the course of nuclei is inverse (minimum at noon), and the ion observations of Wait and Torreson at Washington, D. C. (**9**) also indicate such a variation.

If the connection with other meteorological elements is examined, we find a fair correlation between the number of nuclei and the relative humidity. Figure 3 represents the results obtained at State College and at the Taunus Observatory. Both curves show decreasing numbers of nuclei with increase of relative humidity. That is reasonable, as many, principally the more hygroscopic, nuclei are surrounded by invisible water droplets before the saturation point in the air is reached, settle and thus escape counting (cf. Egloff l. c.).

Room experiments show that by hanging up wet sheets and thus increasing the relative humidity the number of countable particles is decreased by 50 percent in 1½ hours, while without this wetting the number remains nearly unchanged.

The next meteorological element investigated was the wind direction. Figure 4 shows the number of particles correlated to each wind direction at State College. Two

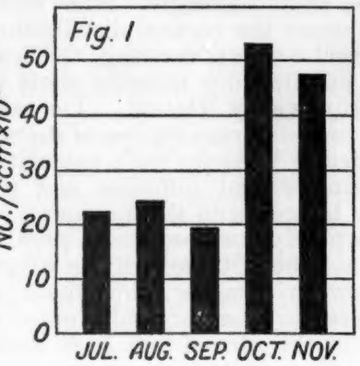
Fig. 1
NO./ccm×10³
0
10
20
30
40
50
JUL.
AUG.
SEP.
OCT.
NOV.

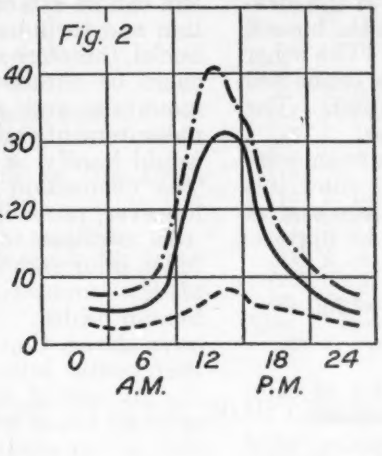
Fig. 2
NO./ccm×10³
0
10
20
30
40
0
6
12
18
24
A.M.
P.M.

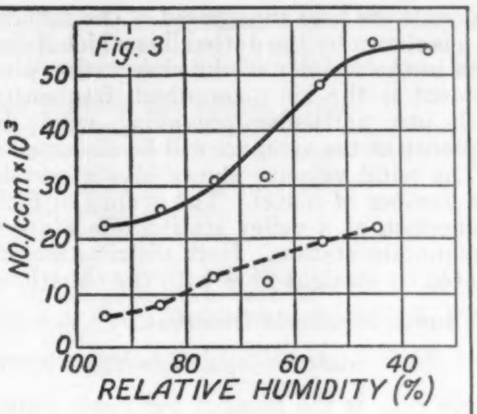
Fig. 3
NO./ccm×10³
0
10
20
30
40
50
100
80
60
40
RELATIVE HUMIDITY (%)

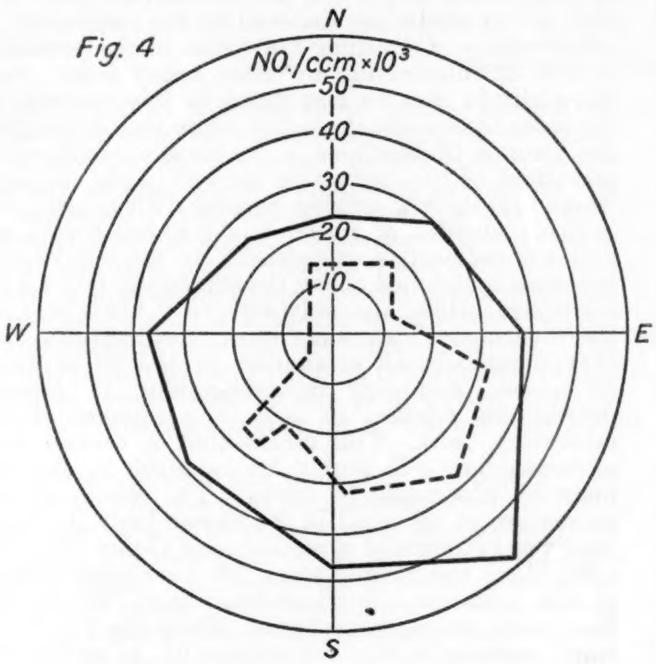
Fig. 4
N
NO./ccm×10³
50
40
30
20
10
W
E
S

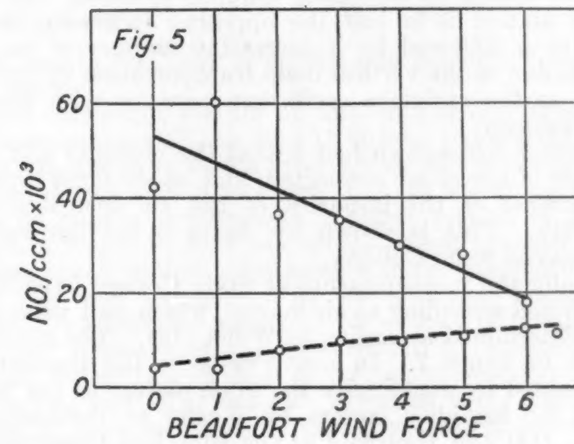
Fig. 5
NO./ccm×10³
0
20
40
60
0
1
2
3
4
5
6
BEAUFORT WIND FORCE

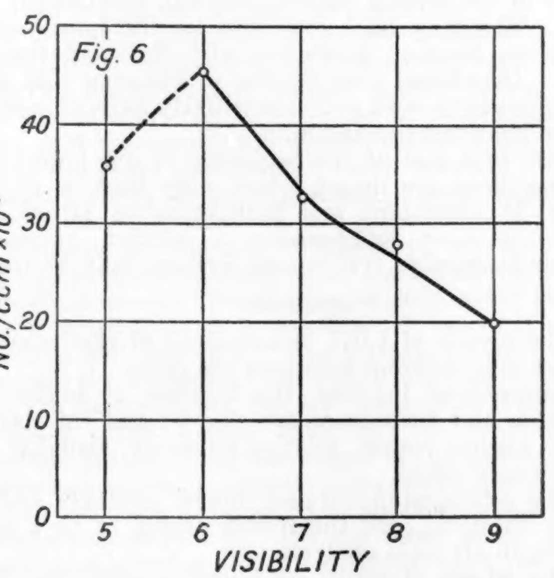
Fig. 6
NO./ccm×10³
0
10
20
30
40
50
5
6
7
8
9
VISIBILITY

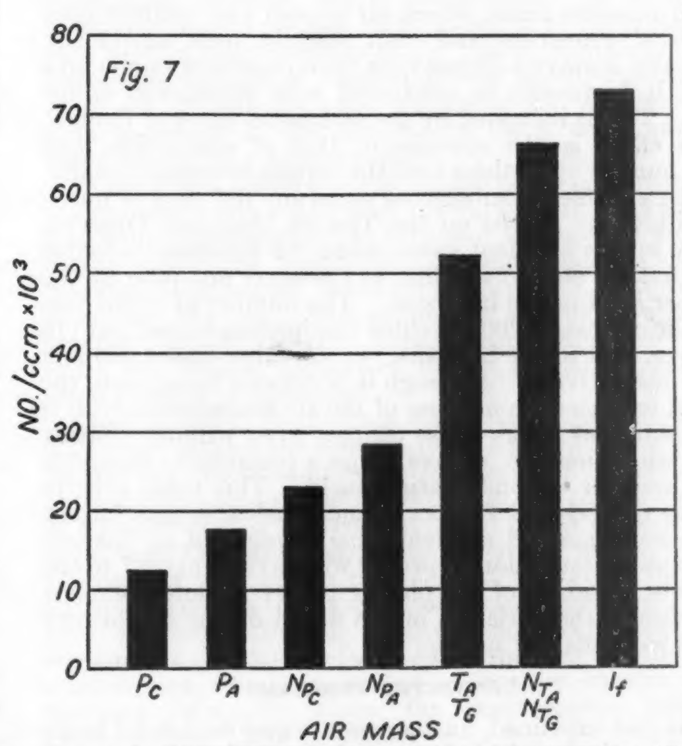
Fig. 7
NO./ccm×10³
0
10
20
30
40
50
60
70
80
P_C
P_A
N_{P_C}
N_{P_A}
T_A T_G
N_{T_A} N_{T_G}
I_f
AIR MASS

elements are here superposed. The influence of the location is shown by the dotted line which delimits the housed area in the vicinity of the observation place. The other element is the air mass which frequently is connected with one particular prevailing wind direction. The influence of the air mass will be discussed later.

The wind velocity shows also a certain influence on the number of nuclei. The graphs of figure 5 show this connection at a valley station like State College and at a mountain station. Both distributions can be approximated by straight lines with the equations:

$$\text{Taunus Mountain Observatory, } N_T = N_{T(c)} + 1200\ F$$

$$\text{State College, } N_s = N_{s(c)} - 8000\ F$$

where $N_{(c)}$ is the number per cubic centimeter at calm and F the wind velocity in Beaufort Scale divisions.

This means that at the higher level, increasing wind velocity brings an increasing number of nuclei. At the valley station it is just the opposite: increasing wind velocity is followed by a decreasing number of nuclei. This is due to the vertical mass transportation by turbulence, as the exchange coefficient increases with higher wind velocity.

Another well-known fact is that the visibility and the number of nuclei are connected; and, as we must expect, an increase of the impurity of the air decreases the visibility. This is shown by figure 6 for the values obtained at State College.

Finally the measurements at State College have been distributed according to air masses, which had generally been determined according to Willet **(13)**. The result is shown in figure 7. In many respects the impurities, represented by nuclei, give the same picture as has been found for turbidity factors by Wexler at Washington, D. C., **(14)** and Haurwitz at the Blue Hill Observatory **(15)**. In addition to the air masses given by Willet, it was thought desirable to specify another type of air mass called, according to the Linke system **(16)** in Europe, I, "indifferent." This type of air occurs frequently in high pressure areas, where air masses lose entirely their original properties and shift slightly back and forth. Usually it stays a longer time than do others in one area and it frequently is connected with subsidence of the air. This is indicated by the additional index of (foehn). The effect is the opposite of that of convection, and the number of particles near the surface increases steadily. That a surface of subsidence stops any diffusion of nuclei entirely was proved on the Taunus Mountain Observatory in two excellent cases, when the inversion subsided so that the station was first at the lower and later at the upper limit of the inversion. The number of nuclei was in the one case 2,200 per cubic centimeters below, and 110 above, that in the inversion; in the other case 4,000 and 300 respectively. Although it is difficult to separate the local influences from those of the air masses entirely, it is evident that an air mass change, even without shifting the wind direction, always brings a remarkable change in the number of condensation-nuclei. This holds even in cases of occluded fronts. Hence nuclear counts furnish one more method of identifying changes of air masses. Future investigations however will have to extend to the points of origin of air masses to get a more complete picture of the variation of the nuclei during the history of a particular air mass.

CONNECTED PROBLEMS

As just explained, nuclear counts may be helpful in air mass analysis, which is one of the major problems in modern meteorology. But another meteorological problem can be attacked also from this angle. Since convection and turbulence influence the vertical distribution of nuclei, therefore more exact values of exchange coefficients could be obtained by simultaneous measurements at a mountain and a nearby valley station. The above measurements taken in such different regions of the world would hardly be a sufficient basis for such calculations. The connection between vertical diffusion and wind, however, probably may be solved in this manner.

In addition to these purely meteorological problems, fuller information can also be obtained on the question of the connection between weather phenomena and human health. Dessauer, Strasburger, and Happel **(17)** have shown that some of the aerosol ions have distinct therapeutic influences. The writer's measurements of the amount of inhaled and exhaled nuclei show that in open air about 40 percent, and in room air about 25 percent, of the nuclei are absorbed by the respiratory tract. Observations of Amelung **(18)** point to the possibility of a kind of intoxication by ultra heavy ions. Another thing should also be mentioned in this connection: At the same time when the writer made the observations at the Taunus Observatory, a graduate student made observations of the emanation content of the atmosphere. These **(19)** show a striking parallel with nuclear counts. A rising amount of nuclei was connected with an increase of radioactive emanation. In the case of the one inversion mentioned above the emanation was 1.2×10^{-16} Curie/ccm below, and only 2.0×10^{-17} Curie/ccm above, the inversion. This and other considerations indicate that practically all emanation in the air is absorbed on nuclei. Following this suggestion, H. Israel **(20)** proved this relation to hold in a number of careful laboratory tests. This means that a certain amount of emanation will surely be retained in the human body by absorption of nuclei. The effects of inhaled emanation as an agent in the human body (be it therapeutic or pathogenic) is evident, and Gerke **(21)**, Aschoff **(22)**, Muck and collaborators **(23)** have established facts of this influence. Furthermore, Flach **(24)** has shown that many pathogenic weather effects are due to downward currents in the atmosphere or, as one may say, surfaces of subsidence. As shown above, such weather conditions increase the number of nuclei, and it is, perhaps, not too bold to infer a connection between these changes in the aerosol (nuclei, ions and emanation) and health. This may hold good also for the formation of the famous Belgium death fog with its stagnating air masses. Occasional observations of Petersen **(25)** on a group of patients with pollen sensitivity likewise seem to point to the same conclusion.

We are here just at the beginning of our knowledge, but some lines are drawn which may lead us to new results. If physicians and meteorologists attack this question in close collaboration a solution, increasing both our knowledge and human welfare, may be found.

SUMMARY

1. The results of 1,051 observations of condensation-nuclei at four different locations are given.
2. Connections between the number of nuclei and convection and turbulence are shown; and correlations between nuclear counts, relative humidity, visibility and wind are mentioned.
3. The relationship between nuclei contents and air mass is discussed, and the former found to be a valuable help in air mass analysis.
4. The effects of nuclei on human health, and their adsorption of radioactive emanation, principally with the occurrence of surfaces of subsidence, are discussed.

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PRECIPITATION IN THE NORTHERN GREAT PLAINS

By W. A. MATTICE

[Weather Bureau, Washington, January 1935]

Abnormalities in weather focus public interest on localities that may be experiencing unusual extremes. Thus, a report of extremely cold or hot weather in the newspapers at once arouses temporary interest in the place mentioned. Also, but to a more limited extent, local droughts are of interest, while floods occupy much space on the front page. Droughts usually are not so intensive in interest as floods, but the severe dry spells that were experienced in 1930 and again in 1934 were of such magnitude as to create wide-spread concern. The region covered in this paper has been the focal point of the droughts in recent years, as the precipitation in many places therein has been scanty for a comparatively long time.

Wide-spread interest has prompted this paper. The charts partially fill the need for detailed climatic maps of the area concerned. The data on which they are based are contained largely in Bulletin W, of the Weather Bureau.

Much comment has been heard in recent years about the suitability of our dryer regions for agriculture, and much of the Northwestern Plains has been classed as only semiproductive or submarginal. So far as temperature is concerned, many staple crops could be grown with profit in this section by selecting those with the proper thermal requirements, but the agricultural utilization of much of this land is limited by moisture conditions.

For ordinary agriculture the average annual precipitation is considered the limiting factor for general farming. However, the average or normal rainfall does not mean that this amount can be expected in 50 percent of the years, as it is generally well known that a greater proportion of the years have rainfall below normal.

Chart I shows the average annual precipitation for the northern Great Plains. In the preparation of this and other charts, the method of Kincer (1) was followed in locating the isohyetal lines. The average annual amounts range from around 25 inches, or slightly more, in southeastern South Dakota to less than 10 inches in parts of Wyoming and Montana. The annual rainfall decreases progressively westward, the region varying from semihumid in eastern South Dakota to almost arid in parts of Wyoming. The higher elevations of Montana and Wyoming are relatively well supplied with moisture, with the average annual precipitation over 30 inches in extreme western Montana and over 25 inches in north-central and northwestern Wyoming. On the other hand, parts of these States have less than 10 inches of rain a year, on the average, notably in the upper Red Rock Valley of Montana and in the lower Shoshone and Bighorn Valleys of Wyoming.

One important feature of this map is the large area with annual rainfall less than 15 inches. As the isohyetal lines are drawn to 2-inch intervals on the even numbers, some interpolation is necessary, but the size of the region can be readily determined. A large section of northwestern North Dakota has, on the average, less than 16 inches a year, while much of eastern and northern Montana has less than 14 inches. As the minimum amount of annual precipitation necessary for successful farming by ordinary methods usually is considered to be between 15 and 20 inches, this region is especially noteworthy. With an annual rainfall of less than 15 inches, other conditions must be very favorable to ensure successful farming in the long run.

In the Great Plains the agricultural significance of the rainfall depends principally on its seasonal distribution, the variations of amount from year to year, or its dependability, and the rate of evaporation. All of these modifying factors operate more favorably in the northern part than in other sections of the Plains, with the result that while rainfall is scantier in the north, conditions there are climatically more favorable for crop growth than elsewhere in the area where the average annual precipitation may be comparable.

In the Great Plains it is the rainfall of the crop growing season that is important from the agricultural viewpoint. The winter precipitation is light and the amount stored in the soil at the beginning of spring usually is small. Normally the rainfall increases rapidly with the advent of spring; May and June commonly are the months of greatest amounts. The warm-season rains comprise much the greater proportion of the annual, except in some districts of Montana.

Chart II shows the average warm season precipitation. This chart covers the months from April to September, inclusive. The amounts vary from around 20 inches in extreme southeastern South Dakota to less than 6 inches in north-central Wyoming. Much of South Dakota has more than 12 inches during this 6 months' period, while the eastern part of the State averages over 14 inches. In North Dakota the average amounts range from 11 to over 16 inches, but in Montana and Wyoming the topography has such a large effect that no definite extensive area can be delimited, except for eastern and northern Montana where the warm-season rainfall averages from 10 to 11 inches.

Chart III shows the percent of the annual precipitation that occurs during the warm season. It will be seen that much of the Dakotas average more than 75 percent of the year's rainfall during the 6 warm months; some sections average over 80 percent, and limited localities

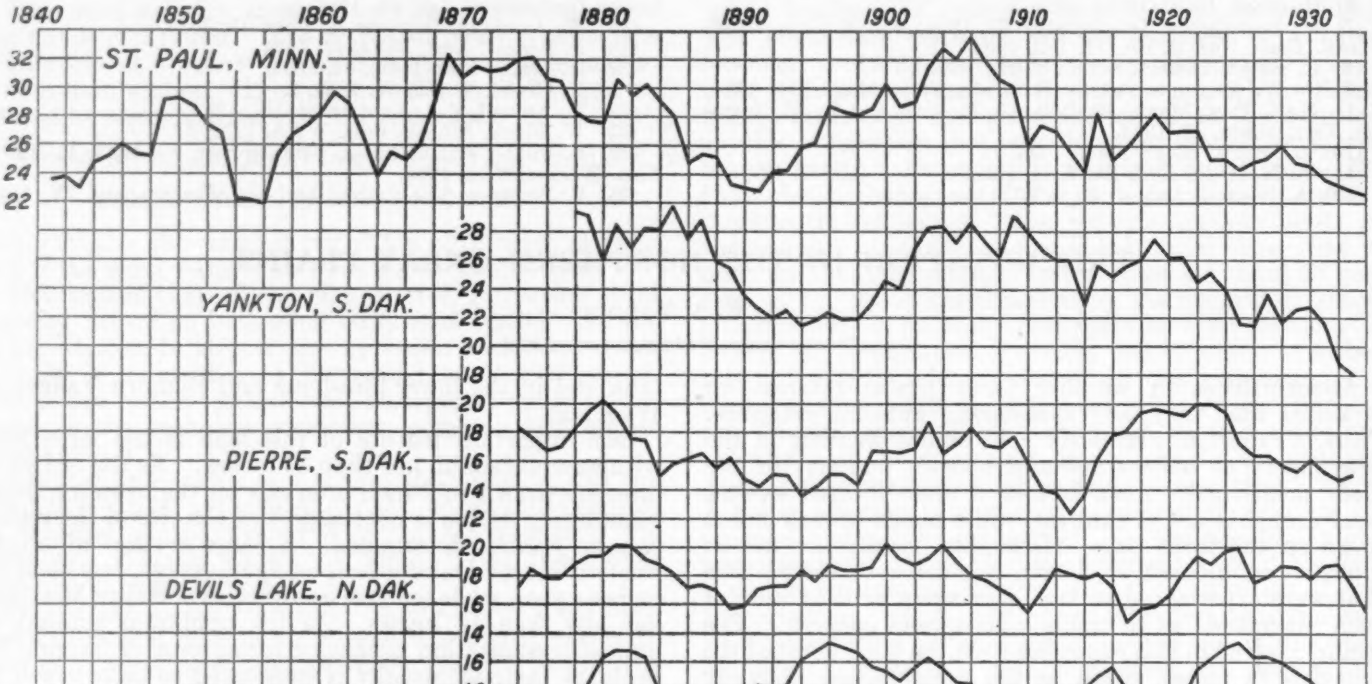
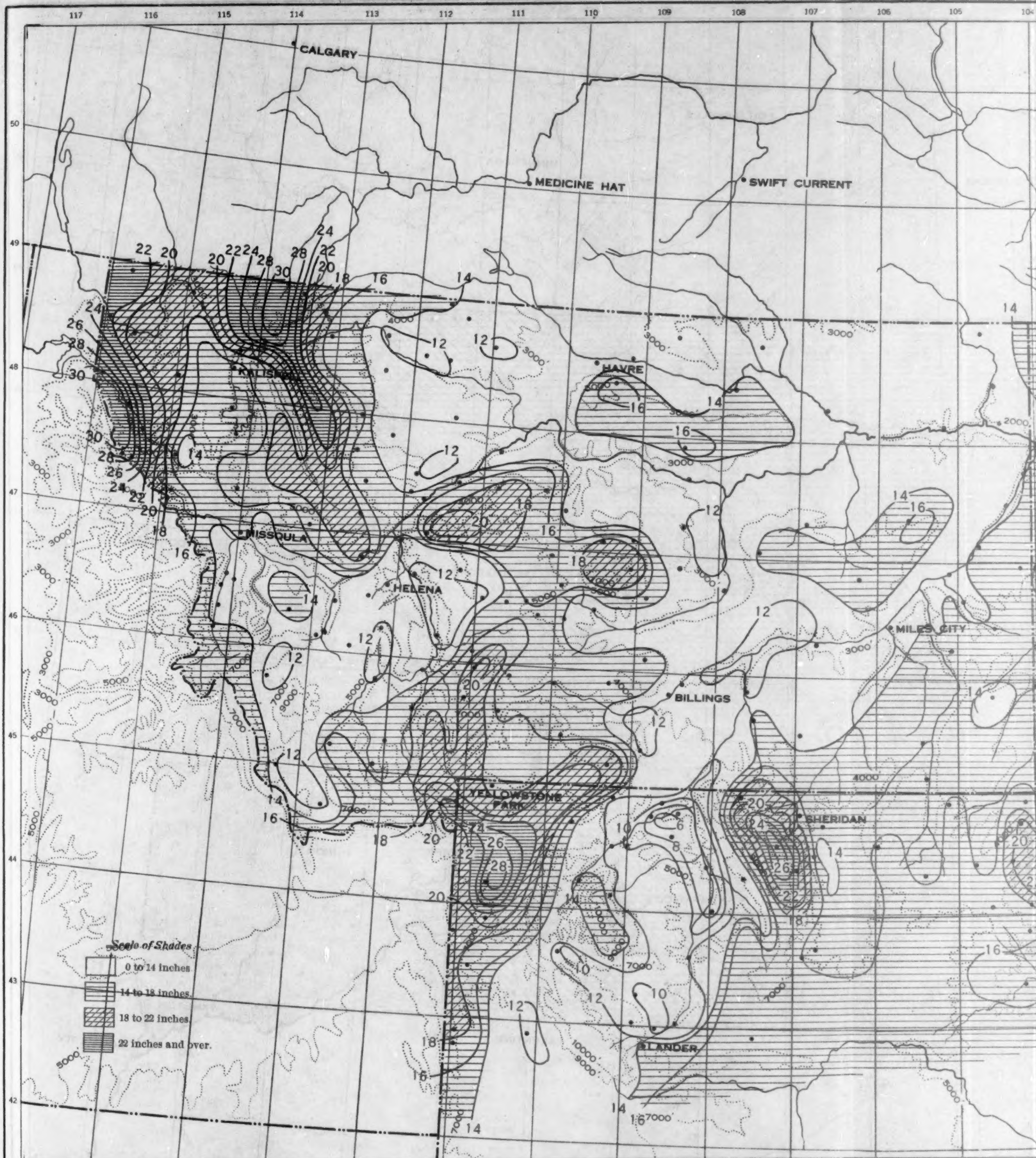


FIGURE 1.—Average annual precipitation by 5-year moving averages for selected stations in the northern Great Plains.

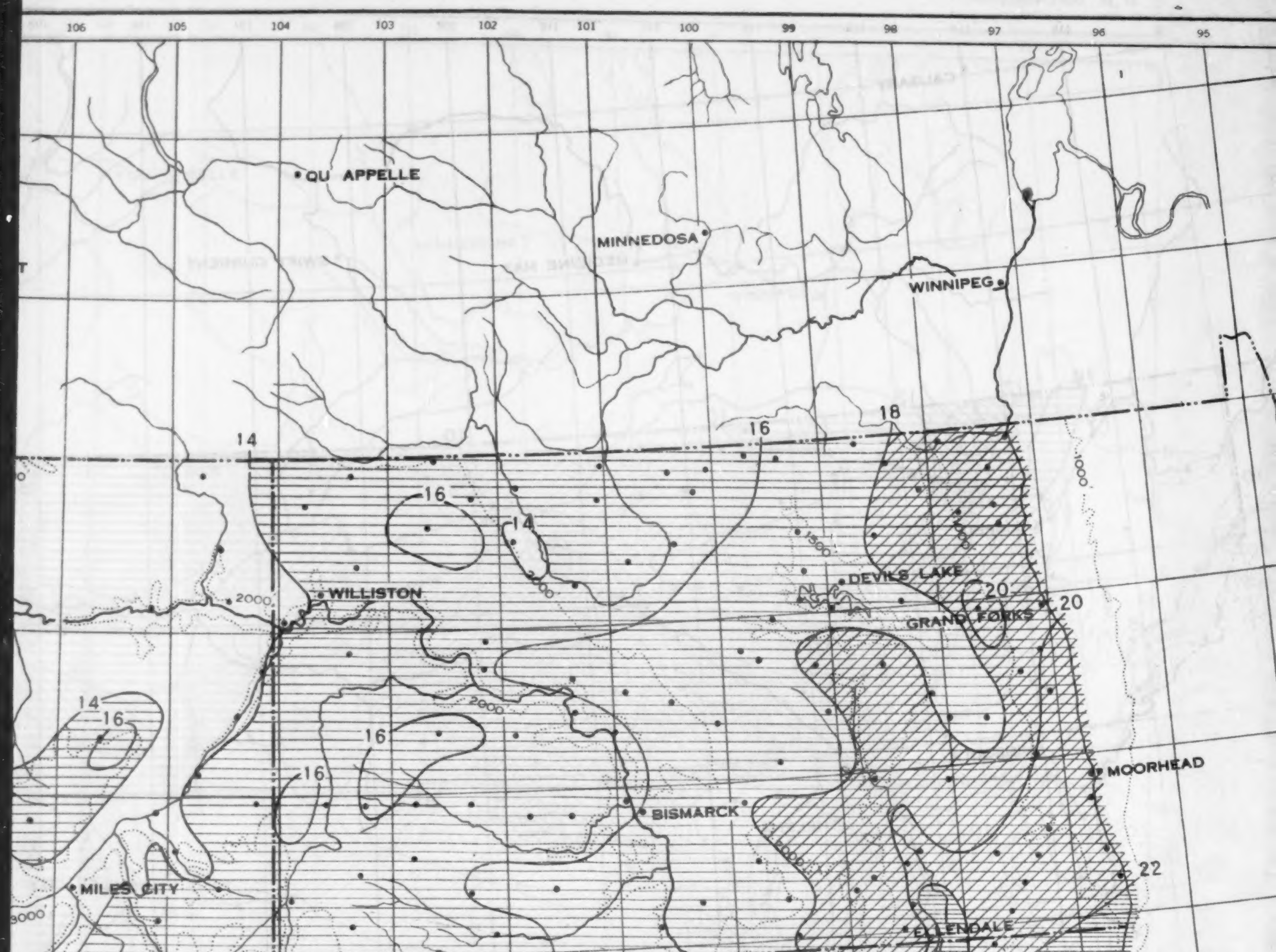
range as high as 84 to 92 percent. In Montana the percentages vary widely, from 80 in parts of the east and north to less than 40 in the western valleys. Wyoming has much the same characteristics as Montana, with the percentages ranging from 40 to nearly 80. As indicated on this chart, the annual rainfall may be small, but the seasonal distribution is very favorable in making much the greater part of the total available for crop growth.

A very important matter in connection with this region is that of droughts. How frequently do they occur and how severe and long-continued are they? The answer to the first question is indicated by chart IV, which shows for a 40-year period, 1894–1933, the percentage of the years with less than 15 inches of precipitation. The minimum amount is very important, and agricultural planning should be made in expectation of recurring droughty periods. The chart shows that the percentage of years with less than 15 inches of precipitation ranges from around 4 in southeastern South Dakota to 80 or even up to 100 in parts of northern Wyoming. Most of Montana east of the Continental

W. A. M. **Fig. 1. Average Annual Precipitation for the**



ual Precipitation for the Northern Great Plains



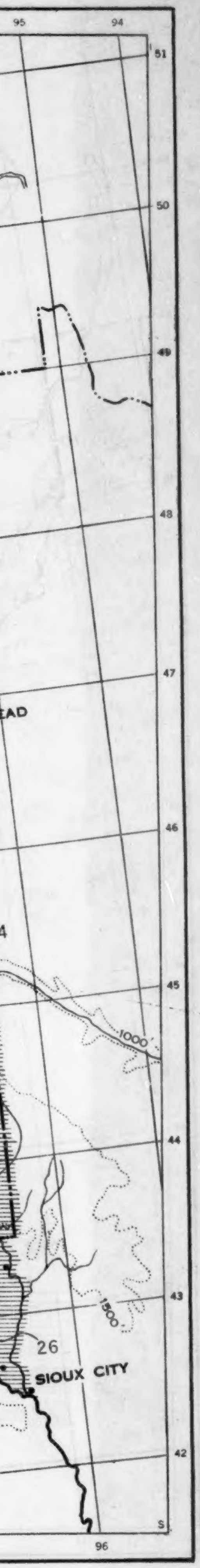

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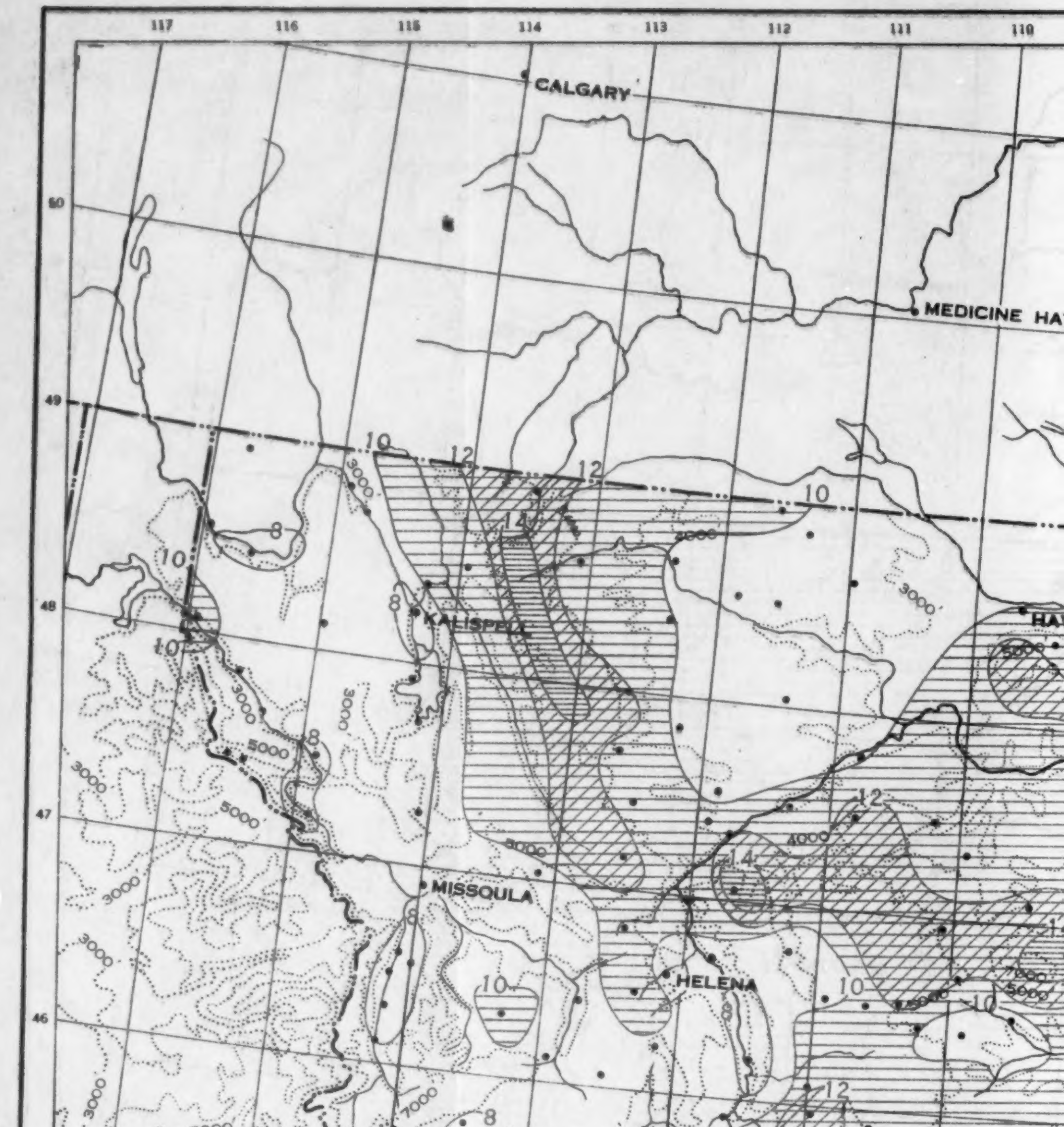
 Fig. 2.


CALGARY
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MISSOULA
HELENA
YELLOWSTONE PARK
Scale of Shades
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10 to 12 inches.
12 to 14 inches.
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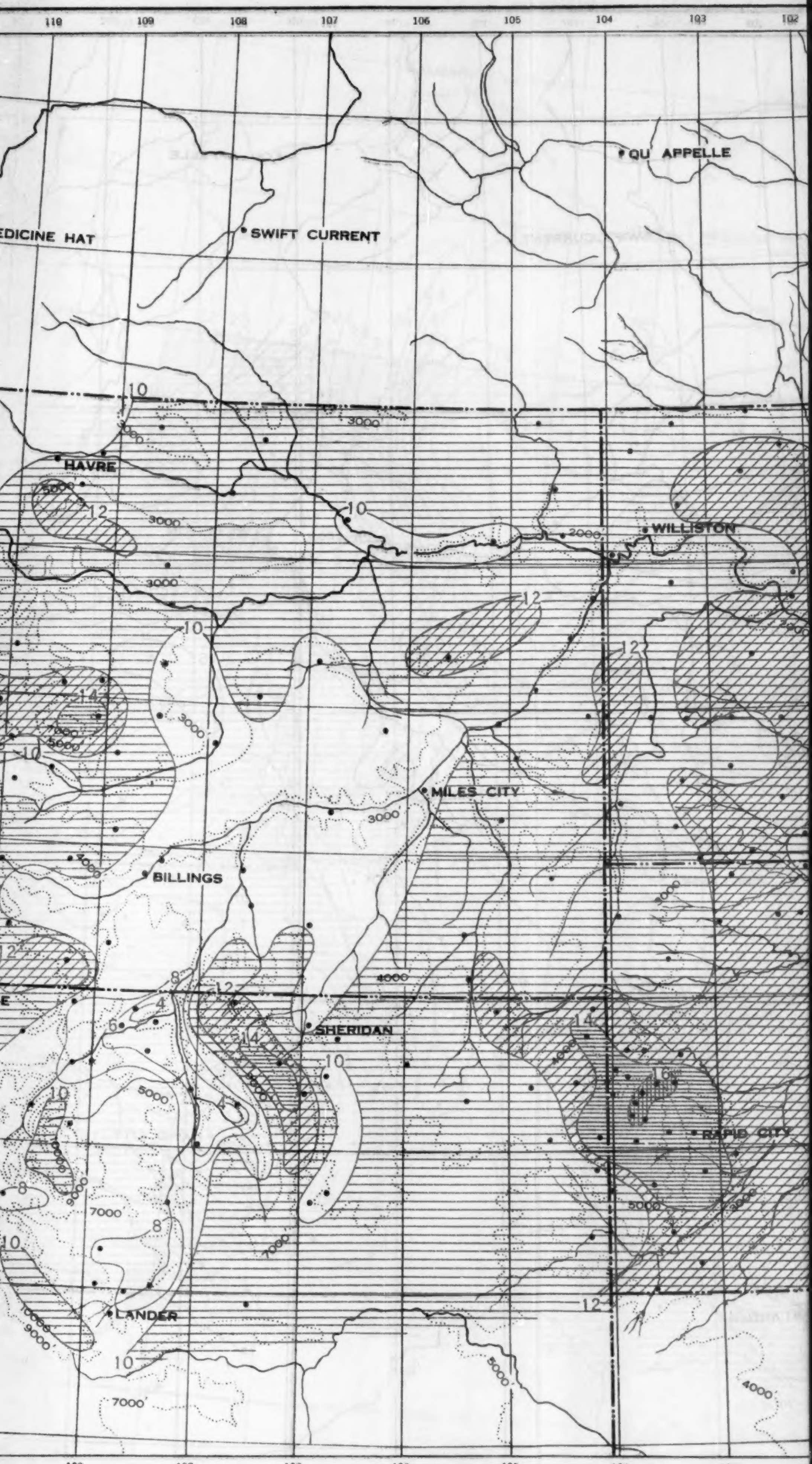
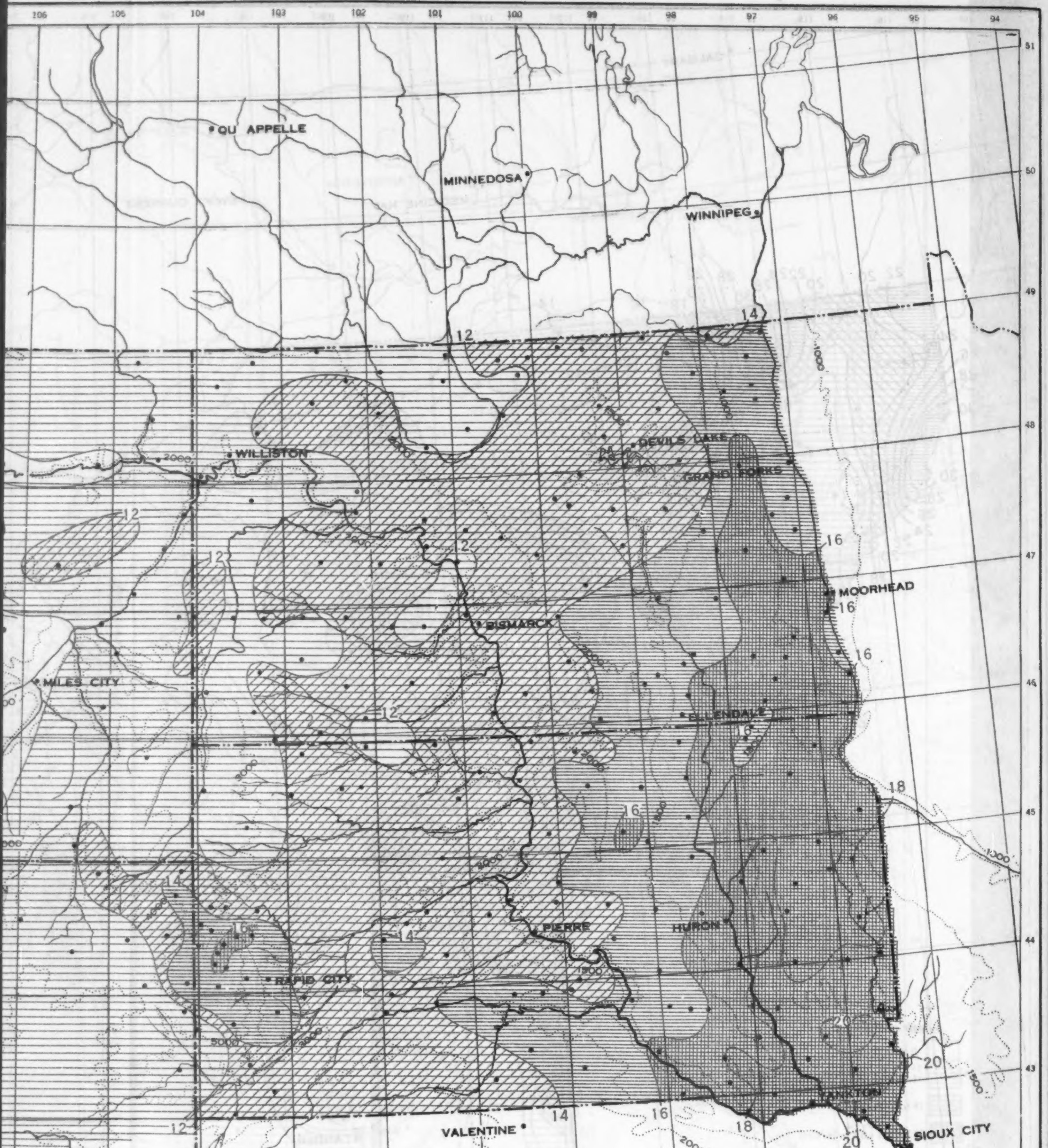
16 inches and over.

Fig. 2. Average Warm-Season precipitation (April-September), for the North

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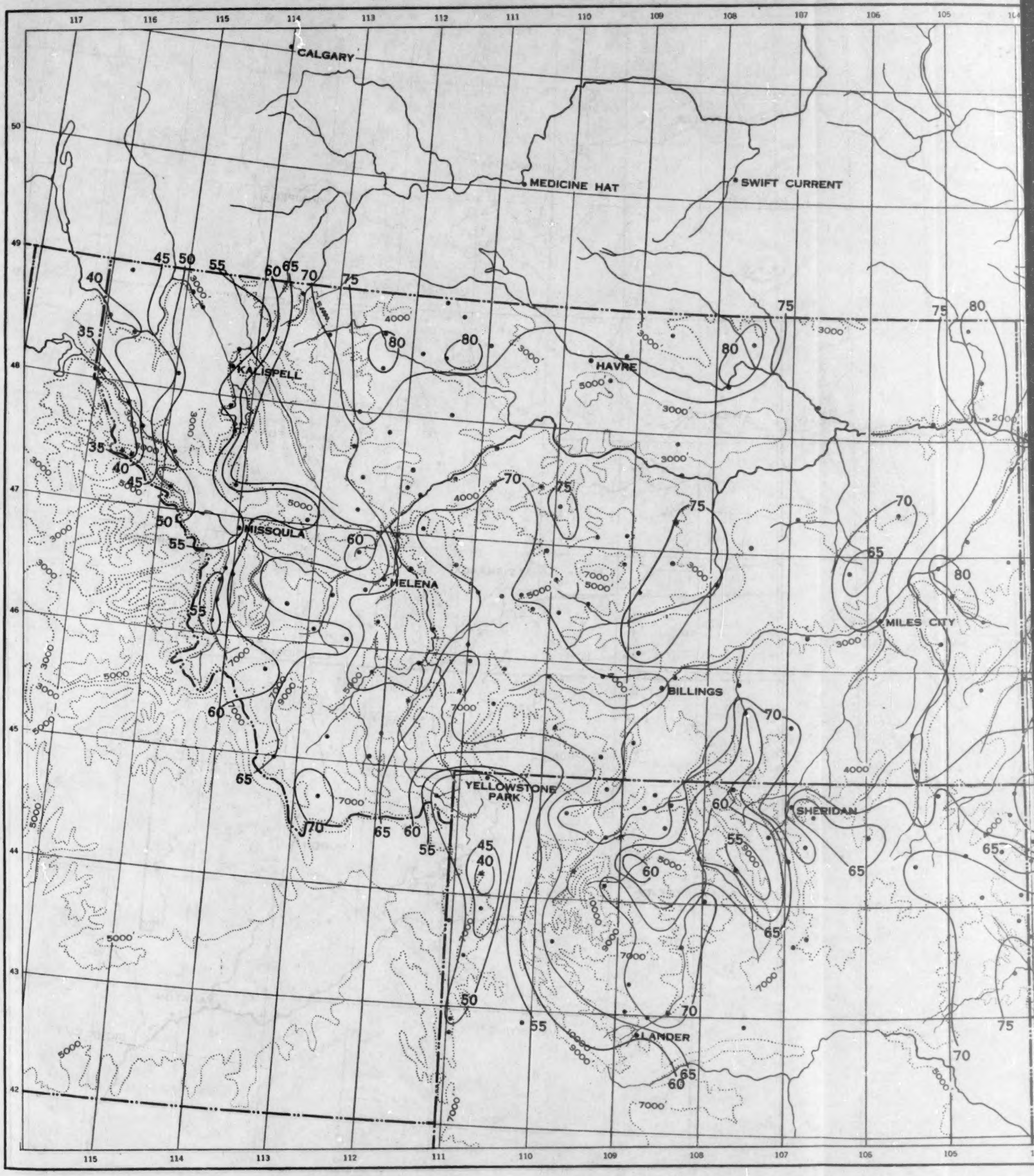
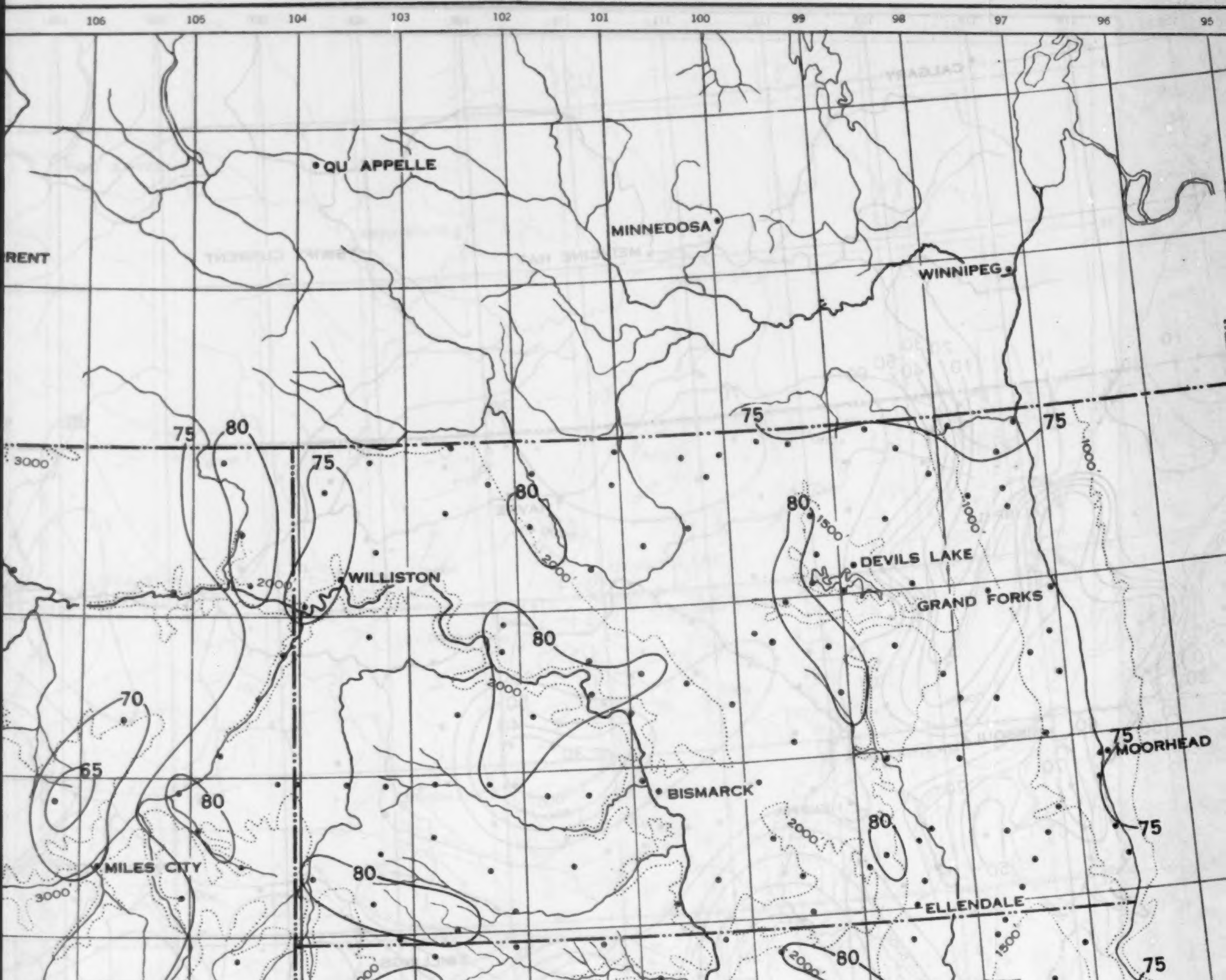
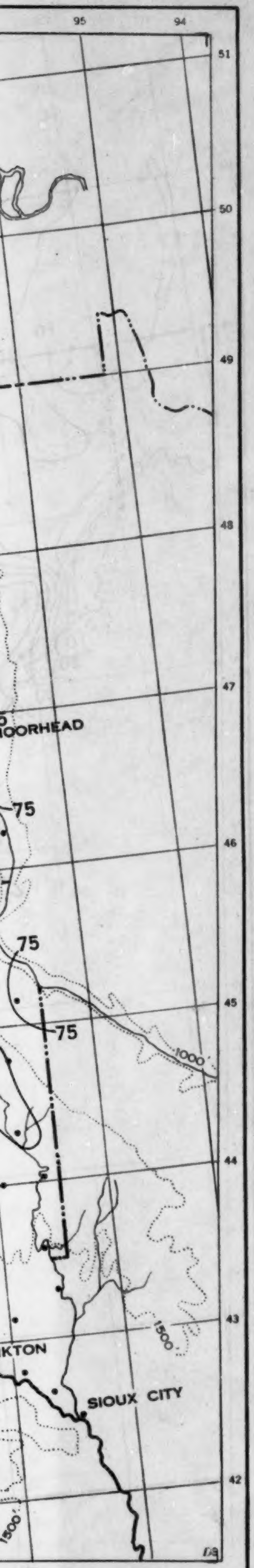
WINNIPEG
WILLISTON
DEVILS LAKE
GRAND FORKS
MOORHEAD
BISMARCK
MILES CITY
ELLENDALE
PIERRE
HURON
RAPID CITY
YANKTON
VALENTINE
SIOUX CITY

W. A. M. **Fig. 3. Percentage of the Annual Precipitation that Occurs Duri**



...cipitation that Occurs During the Warm Season (April-September).

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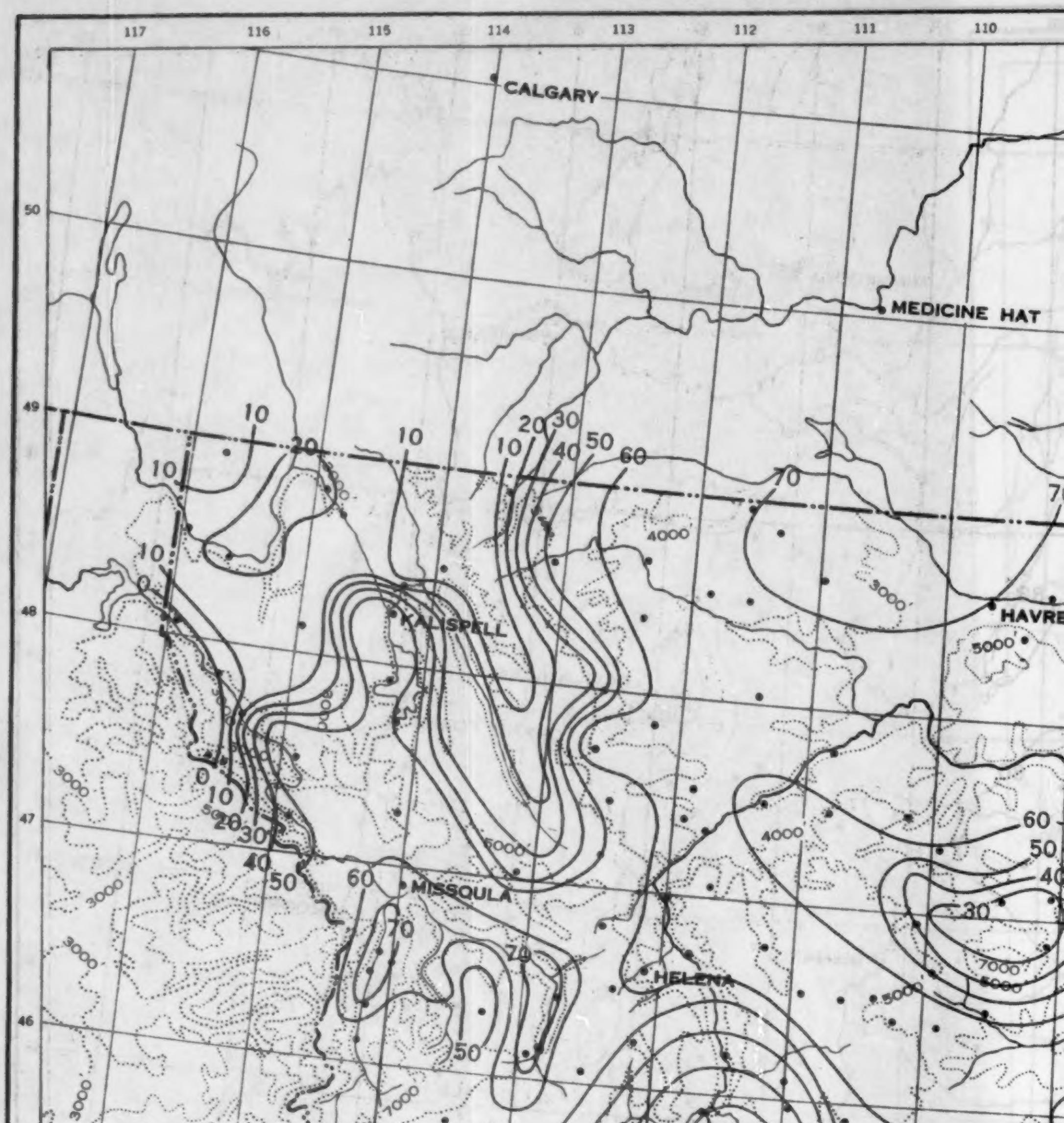
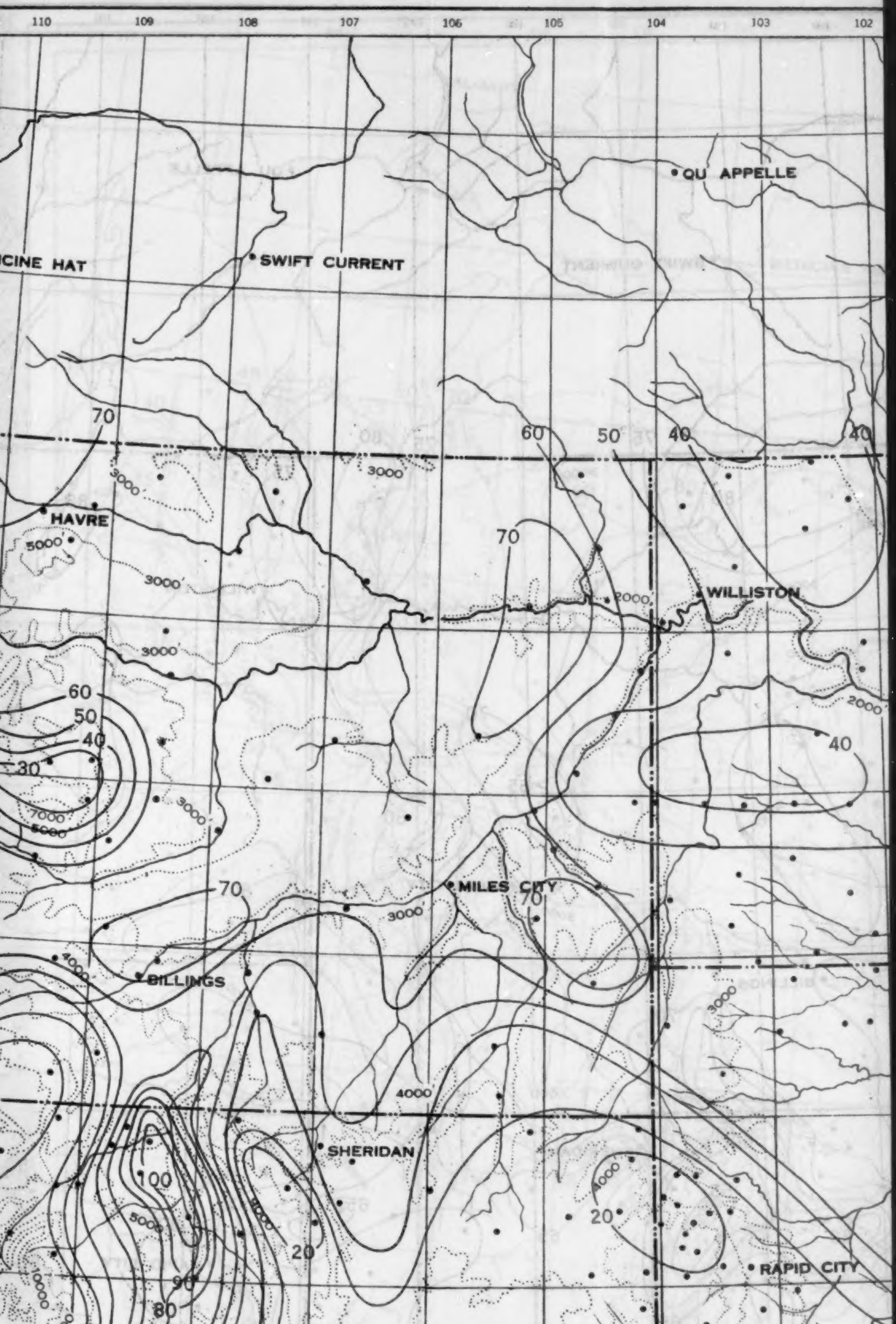
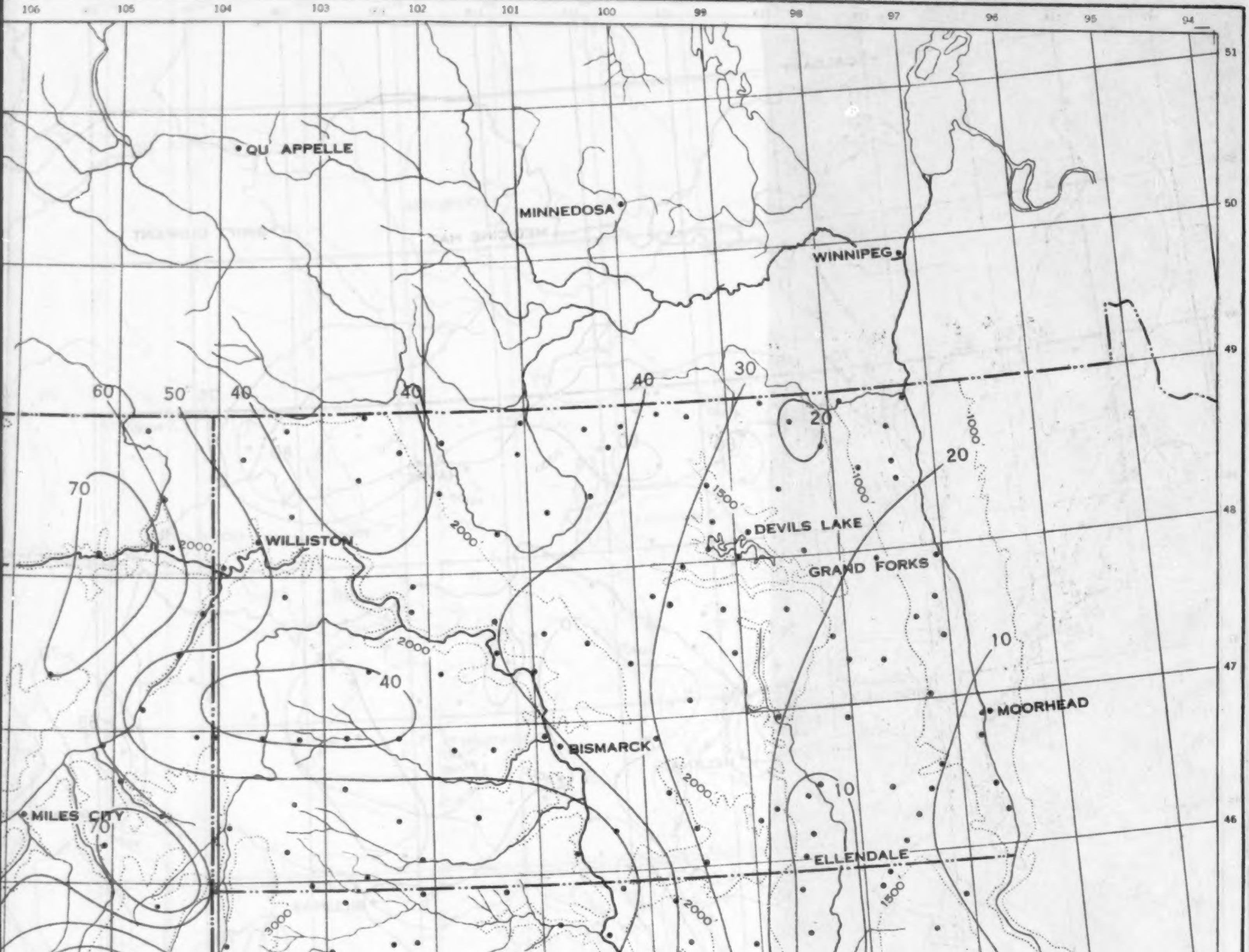
W. A. M. Fig. 4. Perce



4. Percentage of Years with Less than 15 Inches of Precipitation (40 Years' [...]



...an 15 Inches of Precipitation (40 Years' Record, 1894-1933)



Divide may expect an annual rainfall of less than 15 inches in over half the years, although some western localities very rarely have less than this. In North and South Dakota the percentages drop off rapidly to the eastward, ranging from around 40 to 50 in the western parts to mostly less than 10 along the eastern borders.

Figure 1 has a bearing on the question of duration and intensity of droughts. The data shown are annual precipitation by 5-year moving averages; that is, each point on the graphs represents the average for the 5 years up to and including that year. The long-record graph for St. Paul, Minn., is included for comparison with the shorter periods of the stations in the area concerned. Some of these necessarily are combinations of records for nearby stations in order to obtain as long a period as possible. Thus, the data for Williston, N. Dak., represent not only those for Williston, but also those for Buford, N. Dak., a nearby station with an earlier record than is available at Williston.

Similarly the record for Pierre, S. Dak., is combined with a record for Fort Sully, S. Dak., also a nearby station with earlier data. While all of the data are not strictly homogeneous they show the general tendency of precipitation in this area.

The record for St. Paul covers the years 1836–1934, inclusive, while the others are shorter. The sparse settlement of much of this area in the earlier years prevented complete coverage, and it was extremely difficult to maintain continuity of records.

The really encouraging indications of these graphs are the recoveries that were made after previous depressions rather similar to that now prevailing. The trends for Yankton, S. Dak., follow those for St. Paul closely, but in general the stations tend to less variation as they progress westward. Miles City, Mont., shows a long-time drop in annual rainfall similar to St. Paul, but most of the other stations show general tendencies to dryness only during the last few years; for instance, for Williston, N. Dak., the annual trend has just started down, indicating that perhaps this region is tending toward a series of dry years.

The most important feature in all these graphs is the fact that for every series of years with subnormal rainfall there is a subsequent recovery with above-normal amounts for several years. The periods are far from uniform in length, as is readily apparent, but the most striking thing is the alternation of depressions and recoveries just mentioned.

Grateful acknowledgment is made of the invaluable aid and advice freely given by Mr. J. B. Kincer. Acknowledgment is also made of the material that was taken from Kincer's article on the climate of the Great Plains (2).

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METEOROLOGICAL EXTREMES OF THE SOUTHWEST

By Clarence E. Koeppe [1]

[Southwest Missouri State Teachers College, Springfield, August 1934]

The average person remembers the unusual weather which he has experienced, and forgets the normal course; and of this unusual weather, he is likely to remember only that which occurred most recently or which may have made some deep impression upon him at the time. If, as a child, he had an unusual experience of wading through snow up to his hips on Thanksgiving Day, that fact clings to his mind for years; and because no other Thanksgiving since then may have had snow that deep, he knows that the weather isn't what it used to be, notwithstanding that snow, hip deep, to a child might not need to be much more than a foot deep. It may seem, therefore, that the subject here treated would only be aggravating a situation already bad. That can hardly be the case, however, because probably no reader of this article has experienced as much as 5 percent of the phenomena or conditions which are portrayed. To the student of human climatology a knowledge of extremes of weather is quite as significant as a knowledge of averages, since the extremes cause so much property loss and human suffering. The extremes noted here do not in any sense comprise all those observed in the Southwest over even a recent period, for only a small percentage ever find their way into print; and necessarily the source of information herein contained is almost wholly from published records.

Temperature extremes seem to interest the greatest number of individuals, for there is no one who is not affected directly by them unless he should be so fortunate as to be able to seek a more congenial clime when temperature extremes are greatest, namely, in summer or in winter. The person living in a substantial city apartment is less directly affected by drouths and floods, snow and rain, wind and hail, than by temperature.

The most pronounced extremes of temperature seem to be in Colorado, at elevations between 5,000 and 10,000 feet. Pagosa Springs, in the southwest portion of the State, has an absolute range of temperature of 156°, from 95° in July to 61° below zero in February, which was attained during the cold wave of 1933 (1). During that same cold wave, the temperature at Silverton, in western Colorado, dropped to 56° below zero, giving it an absolute range of 149°. Of course, large ranges of temperature are experienced elsewhere than on the Colorado plateaus; Warsaw, Mo., for instance, with an elevation of only 715 feet, has an absolute range of 151°, from 115° in July to −36° in February.

Of all of the southwest portion of the United States, least absolute ranges of temperature are found in southern Texas and Louisiana. The smallest range is 80° at Bay City, Tex., where the highest temperature recorded was 98° in both July and September and 18° in January. San Benito, in southwestern Texas, has an absolute range of 82°, while Louisiana's smallest absolute range is found at Carrollton, 83°. During a 50-year period, the highest temperature recorded in Palestine, Tex., was 108° in August, while that at Port Arthur, Tex., was 102° in June; Palestine's minimum, however, is 6° below zero for February, and that of Port Arthur is but 11° for January. Gulf waters presumably cause these differences.

Even places on the Gulf have their cold waves. At Galveston, Tex., in February 1899, the temperature dropped to 7.5°, causing fish which were caught in shallow warm water to die from chill before reaching deep water

[1] Actively assisted by Mary Botts, Helen McBride, and William Raney, research students. In many instances, new records for drouth and high temperature were established during the summer of 1934.

(2). During a severe cold wave on the Texas coast in January 1918 the temperature fell from 63° to 16° in 12 hours, and this in spite of the warm waters of the Gulf (**3**).

It appears that the highest temperature ever recorded in the Southwest was 127° in July at Parker, Ariz. Maricopa, Ariz., has had a June temperature of 126°. According to States, Kansas ranks second in high temperatures, for it was reported that during a general period of hot winds in western Kansas in September 1931, 120° was reached. This report, however, has been considered very doubtful by the Kansas section director of the Weather Bureau (**4**). Before this, Kansas' highest temperature was 116°, recorded in June at Hugoton. One hundred eighteen degrees, recorded in August at Oakwood, holds the record for Oklahoma's high temperatures, while the highest in Texas was 117° in June at Big Spring. Missouri's highest temperatures were recorded in July at Marble Hill and Warsaw, where they read 116° and 115°, respectively. Garfield, N. Mex., recorded a temperature of 114° in June and 110° in May. Louisiana's highest temperature was reached in August, 112°, at both Liberty Hill and Minden. Prescott, Arkadelphia, and Hemp Wallace, all in Arkansas, have maxima of 111° in August. Colorado's highest temperature, 111°, was recorded at Two Buttes in July and August.

The highest January temperature recorded in Texas was 96° at Fort Stockton. Riogrande, Tex., has had a February temperature of 104°, and also the highest March temperature on record, 108°. Parker, Ariz., which had the highest temperature recorded, also has the maximum recorded for April, 113°. Two other points in Arizona, Aztec and Casa Grande, hold the record for May, of 120°. Buckeye, Ariz., has registered 114° in October, while Maricopa, Ariz., and Fort McIntosh, Tex., hold the November record with temperatures of 101°. The highest December temperature recorded in the Southwest was 98° at Encinal, Tex.

The lowest temperature recorded in the Southwest was −61° at Pagosa Springs, Colo., as already stated Missouri's lowest temperature was recorded at Warsaw, −36° in February. New Mexico's minimum is also −36°, recorded at Haynes in December. Atwood, Kans., with a January low of −33°, experienced the minimum for that state. Chin Lee holds the minimum record for Arizona with a December temperature of −32°. Arkansas' minimum is −29° and Oklahoma's is −23°. Louisiana's lowest temperature was −16° recorded in February at Minden, which also had the highest temperature recorded for Louisiana. There have never been any subzero temperatures recorded in southern Louisiana; the lowest temperature reached there was 1° in February at Amite and near Hammond. Subzero temperatures have been recorded only twice in Dallas, during a 43-year period. The last time was in January, 1930, when the temperature fell to 3° below zero.

Normally, the lowest temperatures of the year come in December, January, or February. In 1932, however, Fort Smith, Ark., experienced 13°, the lowest temperature of the year on March 9, and this is the lowest March temperature of record, having followed a February with a daily excess of 8°. The lowest temperature ever recorded at San Benito, Tex., is 25°; all other stations in the Southwest have recorded lower temperatures.

As has already been stated, the lowest annual absolute minimum for this section is −61° in February, Pagosa Springs, Colo. The lowest minimum of the hottest month is 25° for June and July at Buena Vista, Colo. The absolute highest minimum of the hottest month is 73° in August, at Port Isabel, Tex.; that is, at no other station in the Southwest has the warmest month passed without temperatures going below 73° during at least 1 night.

One of the greatest overnight changes in temperature occurred at Amarillo, Tex., February 7, 1933, when the temperature dropped 70°, from 64° to −6° (**5**). Almost as great a change occurred in Oklahoma City November 11, 1911. At 1 p. m. the temperature was 83°; at 3:30 p. m., it was 32°; and at midnight, 17°. At 3 a. m. of the following day, it was 14°. Eighty-three degrees and 17° are still the highest and lowest of record there for November 11 (**6**). Springfield, Mo., also experienced a sudden drop in temperature in November 1911. At 3:45 p. m. the temperature was 80°, which broke a 25-year record for that month; during the night the temperature fell to 13° (**7**).

The most severe and one of the most recent cold waves of the Southwest was that of February 1933. This caused the unprecedented low temperature at Pagosa Springs, Colo. New Mexico and Texas also experienced cold waves during this period, following abnormal January warmth. The Great Basin States, including the northern part of New Mexico and Arizona, had markedly subnormal temperatures during the winter of 1933, averaging 5° to 10° below normal, making it one of the coldest winters of record in those States (**8**). There were two severe cold waves in the Southwest the latter part of January 1930. In Texas this was the most severe cold wave in a period of 30 years (**9**). At scattered places at high altitudes in Colorado, Arizona, and New Mexico, the temperature fell to between 30° and 40° below zero on November 25, 1931 (**10**). In 1918, there was a severe cold wave on the Texas coast, with a sudden drop in temperature from 63° at 11 p. m., January 10, to 16° at 11 a. m., January 11 (**11**). During the cold wave of 1918 and 1919, Amarillo, Tex., had 37 consecutive days with temperatures of 32° or less. In December 1923, the average daily temperatures for the 2 weeks of cold weather, following a snow storm in the southern mountain and plateau states, were from 10° to more than 30° below normal (**12**).

During a period of hot winds in the summer of 1930, the highest temperature of record in western Kansas was reached in September, when the thermometer is said to have registered 120°. From July 4 to August 16 of that year, 39 out of 44 days had temperatures of 100° or more. This hot wave included most of the Southwest. In Texas, the period of high temperatures started June 17 and ended August 25. Each of those 70 days had temperatures of 100° or more. During the same period in Oklahoma, 64 days out of 66 had temperatures of 100° or more, and Arkansas and Missouri both had more than 1 month with temperatures 100° or more.

There was a hot wave in 1913, affecting particularly Texas and Arkansas. In Arkansas there were 13 days with a maximum temperature of 100° or more, while in Texas there were 6 days (**13**). There was abnormal warmth during June 1933 in the Middle West. The extreme heat prevailed during two distinct periods, interrupted, however, by a spell of very cool weather. The first hot wave prevailed over most of the country east of the Rockies from the 3d to the 11th. Temperatures exceeded 100° at many stations, while 110° was recorded at Wichita and 106° at Concordia (**14**). Brownsville, Tex., once had 105 consecutive days with a maximum of 90° or above, from May 23 to September 4, 1900.

A rather unusual condition exists around Corpus Christi, Tex., where the maximum temperature on most

of the days comes between 11 a. m. and 1 p. m. (**15**). Brownsville, Tex., averages about 1 day in 10 years with a temperature of 18° or lower, and 1 day in 50 years with a temperature of 15° or lower.

Of all the United States, the Southwest, particularly the normally drier portions, has the most erratic rainfall. For a given period the average is seldom experienced. Droughts and floods in varying degrees of severity are to be expected almost every year. It was during August 1922 that ranches throughout most of the Southwest were unfavorably affected by dry weather. At the close of the month, cattle were in poor condition in most of New Mexico and west Texas (**16**). On the other hand, torrential rains in southern and central Texas during September 1921 caused floods which resulted in the death of 215 persons and in damage to property amounting to more than $19,000,000 (**17**).

Records are replete with accounts of excessive precipitation. In all the Southwest probably the greatest single fall of rain was near Taylor, Tex., during the night of September 9 and 10, 1921. A total of 30 inches was recorded in 15 hours, thus averaging 2 inches per hour (**18**). Torrential rains over the southeastern portion of Texas in May 1923 resulted in Beaumont recording nearly 14 inches, and it was reported that the entire amount actually fell in 2½ hours (**19**). In June 1913 nearly 21 inches of rain fell in 18 hours at Montell (**20**). Brownsville received 12 inches in 24 consecutive hours in September 1886, which helped raise the month's total from a mean of 5½ inches to an excess of over 25 inches. Opid's Camp on the west front of the San Gabriel Range reported that slightly over 1 inch of rain fell in 1 minute on April 5, 1926 (**21**). Four inches fell in 1½ hours at Concordia, Kans., on June 23, 1904.

Precipitation for November 1931 was abnormally heavy over an area including eastern Kansas and central Oklahoma, which reported four to six times the normal. Phoenix, Ariz., received nearly five times its normal (**22**). During April 1931 the precipitation at El Paso, Tex., was eight times the normal for the month and was 160 percent of the greatest previous April fall in the 50 years of record (**23**). Galveston, Tex., reported May 1929 as having the greatest rainfall for the month in over 50 years (**24**).

Missouri's greatest annual fall of rain, of a little over 70 inches, occurred at Cassville in 1895. Leroy, Kans., recorded 65 inches in 1915; Calvin, Okla., 70 inches in 1908; and Arkadelphia, Ark., 93 inches in 1905. At Clarksville, Tex., 109 inches is the record established in 1873. During May, June, and July of the same year a total of 53 inches fell. Harvey's ranch, New Mexico, recorded 51 inches in 1919. Pinal ranch, Arizona, recorded 58 inches for the year 1905. The greatest annual fall for Louisiana occurred at Alexandria in 1923, with a total of 88 inches.

In the more or less semiarid portions of the Southwest the fall of rain in abnormal quantities often causes great damages to prospective and matured crops by disastrous floods in the otherwise dry river channels. Outstanding floods of 1923 were those of the Arkansas River from Eastern Kansas to the river's mouth, the Neosho River of Kansas and Oklahoma, and the Cimarron and Canadian Rivers of Oklahoma. Four weeks of almost continuous and frequently excessive rains brought about these floods, the crest stages of which were as a rule higher than any previously recorded. The floods came at the time of matured wheat and growing corn and covered nearly 300,000 acres of productive land in southeastern Kansas and northeastern Oklahoma. The loss and damage, mainly to crops, amounted to approximately $28,000,000 (**25**). There was more rainfall received than normally expected in April during 1922 from central Texas northeast to the lower Ohio valley. Monthly amounts ranged up to as much as 18 inches and in portions of Kansas and Oklahoma precipitation was the greatest of record for the month (**26**).

At Phoenix, Ariz., in February 1931, 300 tourists who had been driven from auto camps at Wellton by a flood which followed a cloudburst 2 days previously had to be fed because they were stranded by impassable roads (**27**). During the flood of the Trinity River at Fort Worth, Tex., in April 1922, 11 persons were drowned, with many others missing. The flood waters were derived from heavy rainfall during a severe electrical storm (**28**). Unusually heavy rainfall in southeastern Arizona during September 1926, resulted in the crest of the Gila River, near the town of Kelvin, reaching 11 feet above flood level (**29**). The Brazos River flood of May 1922, reached a crest stage at Kopperl, Tex., of 48 feet, or 27 feet above the flood stage. This was 11.5 feet above the previous high-water mark of November 1918. Property damage totaled approximately $1,750,000 (**30**).

Excessive precipitation of from 7 to 12 inches during August 1922, in the vicinity of Enid, Okla., and the Cimarron Basin caused the Cimarron River to flood, resulting in the washing out of 19 bridges in Woods County and 18 in Logan County. Two boys were drowned at Oilton, and over 150 square miles of cultivated lands were under water which stripped away the surface soil. Damages totaled several hundred thousand dollars (**31**). Torrential rains in Comanche County, Tex., in September 1910, resulted in a disastrous flood which swept down the narrow channel of the Leon River in a 25-foot wall of water, killing 13 persons (**32**). Heavy local mountain rains caused a flood in the Galisteo River, a tributary of the Rio Grande, in New Mexico during August 1924. The town of Lamy was inundated with a probable loss of $500,000 (**33**).

The Southwest as a whole is subject occasionally to falls of hail which do a vast amount of damage in a short time not only to crops, but also to property and buildings. Reports of outstanding hailstorm losses during 1929 from Kansas totaled $2,400,000 with countless minor losses not reported. Fifteen of the 38 storms came in June. During 1928 Kansas suffered losses of $1,000,000 or more from *each* of six hail storms (**34**). The year 1927 was characterized by 6 days, each with very heavy hailstorms in Oklahoma, Kansas, Colorado, and Texas; the total loss amounted to $7,000,000. Estimates of loss in 1927 from 298 hailstorms totaled $15,000,000; while during 1926, $12,000,000 was the loss in 295 storms (**35**).

In May 1926 a destructive hailstorm in northeastern Texas damaged property to the extent of several million dollars, the greatest damage being in and around Dallas. The hailstones were reported to be the size of moth balls, hen's eggs, and baseballs, some weighing 22 ounces. Scores of people were injured, crops and fruit orchards destroyed, and cows and horses killed (**36** and **37**). In July 1924 a strip of hail 40 miles long and 3 to 7 miles wide fell in Stevens County, Kans., ruining 30,000 acres of wheat. During a tornado at Rocksprings, Tex., in April 1923, hail fell that measured 2 inches or more in diameter, up to the size of baseballs. The noise of its falling on housetops could be heard one-half mile away (**38**). An unusually severe hailstorm swept a path 5 miles wide across Grove and Lane Counties, Kans., in June 1928, leaving fields in the path bare. Horses, cattle, hogs, sheep, rabbits, chickens, and birds were killed.

Hailstones piled into drifts 8 to 15 feet deep, many of which remained for 3 days afterward (**39**). Fine stands of wheat in Kansas were destroyed by hail in June 1928, causing a loss of $2,000,000 (**40**). Stanton, Morton, Grant, Haskell, Seward, Meade, and Clark Counties, Kans., suffered one of the worst hailstorms in history in June 1928; crops and property for 140 miles were damaged to the extent of approximately $3,000,000. Grayson, Lamar, Fannin, Delta, Denton, and Smith Counties, Tex., in May 1926, were damaged $1,700,000 by hail. In June 1931, at Warsaw, Mo., hailstones as big as baseballs fell with such force as to strip homes of weather boarding, kill poultry, birds, and livestock. Ice was formed a foot thick and piled up 3 feet deep immediately after the storm (**41**). The most severe hailstorm that ever visited Corpus Christi occurred in May 1924. Hail one-half inch in diameter fell continuously for almost an hour, associated with strong north winds, vivid lightning, and torrential rainfall of 1.65 inches in 38 minutes (**42**). Wray, Colo., in June 1927, lost about 50 percent of its crops from hail. At Roswell, N. Mex., in October 1930, car tops were perforated, windows were broken, buildings damaged, and cotton and alfalfa crops were beaten by an 1,800-yard-wide path of hail that caused $90,000 damages. Barton, Pawnee, and Stafford Counties, Kans., in June 1927, were damaged to the extent of $2,000,000 by a 30-mile-wide path of hail.

In January 1929 no other Weather Bureau station in the plateau region had so much snow on the ground as Flagstaff, Ariz. The deepest snow, 19 inches, was about 100 miles north of Flagstaff (**43**). A few days before Christmas 1929 Texas was visited by a snowstorm of unusual severity, which paralyzed traffic in the central part of the State. In the panhandle of Texas heavy snows are common, but in central Texas snows are rare, while farther south near the Gulf and along the Rio Grande snow is practically unknown. In this storm northeast Texas had no snow, while central and southern Texas had very heavy snows, 26 inches falling at Hillsboro (**44**). Ten inches of snowfall on Pike's Peak in June 1928 marooned 25 tourists (**45**). In December 1924 sleet and snow impeded Oklahoma's railway and street traffic and damaged overhead wires to the extent of $500,000.

Corpus Christi, Tex., and the surrounding counties suffered from damages to trees, flowers, citrus-fruit trees, and telephone and telegraph lines by ice and sleet in December 1924. In 1911 at Springfield, Mo., the first snow of the season fell in October; and from then to March the total amount was 53 inches as compared with the average annual snowfall of about 15 inches. During January 1912 in the same city the ground was covered for 24 days; snow occurred on 41 days, and on the 20th of February a total of 20 inches was recorded, which exceeded all previous 24-hour snowfalls, and was more than had ever before been recorded in a single month (**46**). Beginning late in November 1923, snow overspread the panhandle of Texas and extended into eastern Kansas, western Missouri, and Arkansas. Locally in eastern Kansas the fall was the greatest reported for the entire month of November for any previous year (**47**). Snow fell throughout Arkansas in January 1910, the depth ranging from 1 inch in counties bordering Louisiana to 10 inches in the upper Ouachita Valley. This distribution is unusual, as the heaviest fall of snow usually occurs in the northern part of the State (**48**).

A sleet and ice storm of great severity occurred at Corpus Christi, Tex., during December 1924. The coating on the wires and trees was so heavy as to cause wires to break. In the latter part of the month there was an inch of snow and sleet on the ground, a very rare occurrence for that section (**49**). In December 1929 States bordering the Gulf from Texas to Alabama reported the greatest average snowfall on record for the month (**50**). Alexandria, La., received 8 inches of snow during December 1901. This was the greatest fall on record.

In December 1923 a storm attended by heavy snow spread over the southern mountain and plateau States centering over New Mexico. Drifting snow completely tied up automobile traffic and nullified railroad schedules. This was followed immediately by much colder weather (**51**). During December 1924 snow occurred as far as the extreme southern part of Texas, amounts of 1 inch or more being reported from the lower Rio Grande Valley (**52**). During January 1930 moderate amounts of snow fell much farther south, particularly in Texas and the Lower Mississippi Valley. In Oklahoma the amount was 50 percent above that of any previous January (**53**).

In the Arkansas River from Cimarron to Wichita, Kans., ice jams in early February 1924 were productive of local floods. The ice conditions were said to have been the severest in the history of the State of Kansas. The ice extended for over 300 miles (**54**). According to a newspaper dispatch, the Rio Grande at San Marcial, N. Mex., during the latter part of December 1932, was blocked by ice for the second time in history (**55**).

The antithesis of rain, snow, hail, and flood is drought. The readily remembered 9-month drought of 1930 reduced the precipitations of many States to much below normal, Arkansas having the lowest record of all (**56**). During August and September 1933 a drought occurred in southwestern Kansas which caused a migration of thousands of jackrabbits from the parched lands to greener pastures. Lane and Ness Counties were swarming with rabbits. A traveler reported that he found it almost impossible to drive along the country roads without killing them. It was here that wheat was almost a complete failure and crops planted in the spring did no better (**57**).

A severe drought occurred at Springfield, Mo., during May and June 1911, which was almost without rain, breaking all records in this locality for continuous dry weather for that time of year. In Oklahoma, June of the same year was the driest month on record, causing a scarcity of water for stock. It was during 1911 that Kansas and Missouri had the hottest and driest weather on record for the month of June (**58**). In 1930 Missouri had the driest July in more than 60 years. The same year was the second driest on record in eastern Kansas. While drought prevailed over the United States, Colorado had more rain in July than any other July except 2 in 43 years of climatological history (**59**).

During 1924 and 1925 a drought continued for over a year in New Mexico, and in parts of Arizona the water supply was the lowest ever known. These States received practically no snow, which is very unusual (**60**). At Oklahoma City, during August 1922, there was recorded the least amount of precipitation ever observed for the month at that station. Portions of eastern New Mexico had a drought that persisted through June, July, and August, resulting in the driest summer ever known (**61**). One of the most serious droughts in the history of the State of Arkansas occurred at Little Rock in 1930. It lasted for 107 days during which less than 1 inch of rain fell (**62**). July 1924 was the driest on record at points in eastern Texas and was among the driest on record at points in Arkansas and Louisiana (**63**).

With an average of over 27 inches of precipitation, Brownsville, Tex., frequently suffers long droughts. The longest period of drought on record was during the years 1893 to 1902, a period of 10 years. During that time rainfall did not total as much as 20 inches in any 1 year. This drought led to the development of irrigation and convinced farmers of its worth (**64**).

The weather during the month of December 1910 was the driest on record in New Mexico, while in Oklahoma the long-continued drought of the same year was the cause of the poorest stand of wheat in the history of the State (**65**). The drought of 1929 in Texas was the severest and longest dry period of record during the growing season. This drought started in the central part of the State about the close of May and continued persistently for over 3 months, during which period the total rainfall at Dallas was only 1 inch. Crops were materially damaged by the continued hot, dry, and cloudless weather. Cotton was so poor that a second picking would not pay for harvesting, a condition which seldom occurs. This drought, however, was partially relieved on September 5 and 6 (**66**).

In September 1925 the cotton crop was seriously reduced in yield from central Texas southward because of the lack of rain (**67**). Southern Texas and the north plains received only 50 percent, or less, of the usual amount of rainfall during January 1932 (**68**). From October 1851 to May 1852 only slightly more than 1 inch of rain fell at Albuquerque, N. Mex. At Roswell the continued lack of rain during June 1925 had resulted in lowering the flow of water from artesian wells to unprecedented levels; and where they normally flowed spontaneously it became necessary to resort to pumping, and even that failed in many wells (**69**). The precipitation was noticeably deficient at all stations in Missouri during March 1910. In general the total amount of rainfall was only about 14 percent of the normal (**70**).

Lightning struck oil tanks, causing a $250,000 loss during a wind, rain, and electrical storm in August 1924, at Tulsa, Okla. A severe thunderstorm southeast of Dodge City, Kans., in August 1924, caused the death of 1 person and 5 horses. In a thunderstorm at Port Arthur, Tex., in July 1931, lightning caused an explosion and fire on an oil barge, resulting in $73,000 damages and the loss of one life.

Probably the most dreaded of extreme meteorological conditions of the Southwest is the tornado because it arrives with so little warning. Fortunately, this phenomenon becomes less frequent with progress westward, although winds of high velocity are not infrequent. Thus, on April 5, 1895, Amarillo experienced a northwest wind with a velocity of 84 miles per hour, probably one of the highest on record, while at El Paso on the same date the wind blew 78 miles per hour. Galveston seems to hold the record for the Gulf coast with 71 miles per hour, registered August 17, 1915 (**71**). These high winds are exclusive of those which occur in hurricanes and tornadoes; these are vastly more violent.

Arizona seems to be the least affected by high winds of a serious nature, although a wind velocity of 58 miles per hour was recorded at Flagstaff one October. There was a rain, hail, and wind storm in August 1928 at Phoenix, Ariz., which caused $100,000 damage to communication lines and business houses. This is the only storm of consequence found recorded in that State. There is one interesting story, however, told of the Arizona winds and international relations: In April 1929 rebel bombs intended for Naco, Sonora, were apparently blown by the prevailing south wind over Naco, Ariz. (**72**).

Colorado has evidently had few destructive tornadoes compared with such States as Kansas, Arkansas, or Texas. The only serious one recorded for the southern part of this State is a tornado and hailstorm near Fowler, in October 1930. The path of this storm was about 880 yards wide. Three persons were killed, and three others were injured. The property damage was estimated at $30,000 to houses, farm buildings, and equipment; three automobiles were totally wrecked.

The worst tornado recorded in northern Louisiana was in Caddo and Bossier Parishes, May 13, 1908. The tornado's path was over one-fourth mile wide, and 20 miles long. Forty-nine lives were lost, and the property damage was estimated at $70,000 (**73**). Another destructive tornado was that of April 4, 1923, at Pineville and the northern part of Alexandria, in which 14 persons were killed, with a property damage of $750,000 (**74**).

Arkansas appears to have been visited by tornadoes more frequently than other of the Southwest States. This partial record shows how wide-spread they may be: 34 on June 5, 1915; 28 on November 25, 1926; 25 on May 9, 1927; and 22 on April 10, 1929. In those of April 1929, 68 lives were lost, with a property damage of $830,000. During the period from 1916 to 1923, 76 tornadoes occurred in Arkansas. In these, 231 persons were killed, 91 of them in 1916 alone. These 76 tornadoes resulted in $2,400,000 damage; and in the year 1921 the total loss from tornadoes was $1,500,000. In the Green Forest tornado of 1927, 22 persons were killed and 100 injured. There was a great property loss (**75**). In the Heber Springs tornado, November 25, 1926, 20 were killed, 75 injured, and there was a property damage of $400,000. At Hot Springs, November 25, 1926, 10 lives were lost and 45 persons were injured in a tornado which was approximately one-fourth mile wide and 9 miles long; there was $300,000 property damage (**76**).

Damage from winds and tornadoes in New Mexico and Arizona is relatively infrequent. Albuquerque seems to have the record for high wind in New Mexico, 63 miles per hour. On May 31, 1930, however, a tornado did pass through Wagon Mound, N. Mex. More than 40 homes and 8 business houses were destroyed, with a loss of 3 lives; 20 persons were injured, and $150,000 damage done to property (**77**). Just about a year later, a tornado passed through French, Colfax County, 35 miles northeast of Wagon Mound, and on into Union County. Buildings were damaged, and a 3-year-old girl died of injuries received. The storm path was 90 miles long (**78**).

The St. Louis tornado of May 27, 1896, killed 72 persons, injured 500, and caused $22,000,000 damage to property (**79**). Thirteen persons were killed in a tornado in southwest Missouri, March 11, 1920, and there was $100,000 property damage in one town alone (**80**). Twelve miles northwest of Springfield, April 10, 1922, two persons were killed, many injured, and $100,000 property damage inflicted by a tornado. During the period 1916–23, 57 tornadoes occurred in Missouri, resulting in the loss of 123 lives. The greatest number of tornadoes in 1 year was 30 in 1917. The greatest loss of life in 1 year was 84 in 1917. Total damage was $3,500,000. The greatest damage in 1 year was $1,550,000 in 1917.

During the period 1916–23, 50 tornadoes occurred in Oklahoma with 144 lives lost during that period. In 1920 alone, 64 were killed. During this 8-year period the property damage was $2,600,000. Damage in 1922 alone amounted to over $1,000,000. In June 1928 tornadoes accompanied by hail occurred in Oklahoma and southern Kansas, killing 12 persons and injuring more than 100; property damage was estimated at $4,500,000. In 4

counties around Altus, Okla., 445 houses were destroyed or damaged (81).

During a 15-year period Kansas had 176 tornadoes, resulting in a total of 102 deaths, and total damage of $9,600,000 (82). The most destructive tornado in the history of western Kansas occurred at Great Bend, November 10, 1925, killing 11 and injuring more than 50; the property damage was estimated at $1,000,000 (83). Ten persons were killed and 300 injured in the Hutchinson tornado of May 7, 1927, which caused a property loss of $1,300,000 (84). Eight counties in southwestern Kansas were swept by hail and wind storms from June 16 to June 20, 1928, when damage to crops and buildings totaled $3,000,000 (85).

In Kansas the most damaging winds are known as "hot" winds. These often sweep from the South during a dry, hot period of summer with shade temperatures ranging from 100° to 110°. They cause rapid desiccation of growing crops. High winds of early spring often cause much damage by blowing off the loose upper soil, especially if it happens to be dry. In such cases soil may be blown from the roots of wheat, or the plant may suffer mechanical damage by rapidly moving particles of sand carried by the wind. In many cases soil has been known to drift like snow along fences or other obstructions (86).

There have been several tornadoes in Texas which have resulted in an appalling loss of life and property. That near Bynum on May 6, 1930, caused the death of 38 persons and a property loss of $2,000,000. Seventy-two persons were killed and 200 injured in the famous Rocksprings tornado of April 12, 1927. This storm had some interesting, if not unusual, features: it occurred in a semiarid region; it was preceded by hail of baseball size; it apparently had no characteristic funnel-like cloud; and the storm was of surpassing violence (87). In 7 other tornadoes, there was a total loss of 70 lives. A hurricane visited a large area of southeast Texas from August 12 to 14, 1932, killing 40 people and causing a loss of over $7,500,000. The terrible Galveston hurricane in 1900 and the recent destructive Brownsville hurricane are too well-known to need further attention here.

Fortunately many of the meteorological extremes discussed here may never be experienced again, at least not for generations. On the other hand, new extremes are certain to occur. The resourcefulness of man, however, can be counted upon. Walls to keep out tidal waves, rows of sturdy trees for windbreaks, dams to stop and store flood waters, widespread irrigation projects in areas subject to drought, development of new species of plants better adapted to meet extremes of weather—all these and more will serve to mitigate the ravages of meteorological extremes of the future.

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RELATION BETWEEN VISIBILITY RESTRICTIONS AND AUTO MISHAPS IN GREENSBORO, N. C.

By JOHN C. SCHOLL

[Weather Bureau, Raleigh, N. C., December 1934]

Careless and reckless driving, ignoring traffic rules and ordinances, mechanical defects in vehicles, excessive use of intoxicants, and numerous other reasons have been advanced as the chief causes of auto mishaps.

Little consideration seems to have been given to the possibility that visibility restrictions are either the direct or indirect cause of more wrecks than is generally conceded. The old saying, "The clearer the day the harder they hit", seems to have been almost universally accepted. It is the contention of the writer that many wrecks, which are attributed to other causes, are actually the result of lack of sufficient visibility to enable the driver to obtain a clear, unrestricted visualization of a situation in sufficient time to prevent a mishap—action taken in a split-second frequently causes or prevents mishaps. The present study of the relation between visibility restrictions and auto mishaps in the city of Greensboro, N. C., is based on a 4-year record, October 1930–September 1934, inclusive.

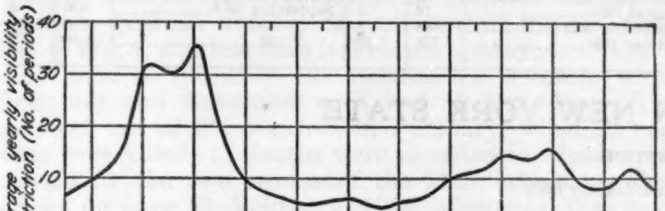


FIGURE 1.

Figure 1 shows the frequency distribution of the periods of restricted visibility during the 4 years; abscissae are midpoints of the periods. In this study restricted visibility is defined as any condition under which the visibility is restricted to 6 miles or less—irrespective of the cause of the restriction. The expected peak at 6 a.m. is undoubtedly due to the "clustering" around this hour of that menace to transportation—fog.

During the period under consideration there were 2,113 auto mishaps in the city of Greensboro, an average of 1 wreck every 16.6 hours. During the periods of restricted visibility there was on the average of 1 wreck every 11.7 hours. During times of unrestricted visibility the average was 1 wreck every 18.3 hours. The difference is even more striking when it is remembered that a preponderance of the cases of restricted visibility are centered around a period of the day which is unquestionably one of relatively little traffic (figure 2). It therefore seems logical to assume that if the periods of restricted visibility were spread out more uniformly, instead of being clustered to such a marked extent around the hours of least traffic, then the difference in the numbers of wrecks during the hours of restricted and of unrestricted visibility would show even more convincingly that there are considerably more wrecks during times of restricted visibility.

It is significant (fig. 2) that the only instances in which line B is above line A are during those times in which visibility restrictions are most frequent (with minor exceptions during later hours of the day). Line B comes under line A about 6:40 a. m., and this is almost the identical time of the very noticeable decrease in visibility restrictions (fig. 1). It must be admitted, however, that there are certain other factors in regard to early morning driving which are favorable to mishaps; motorists are likely to be in a sleepy mood during this period of the day and less alert and active; but it does not seem that any reasonable allowance for these conditions would be sufficient to counteract, or even affect to any great extent, the above comparisons. The hour in which the greatest number of wrecks occur (8 p. m.) is one in which visibility restrictions are quite frequent.

It is admitted that this study shows no evidence of any relation between visibility restrictions and the secondary peak in line B, at 4 p. m. This rise at 4 p. m. is almost identical with the results of similar studies made in other cities. It has frequently been attributed to the circumstance that factories, schools, business houses, and offices usually close about this time of the day. This period consequently becomes one of heavy traffic; and the school children and workers who cause this additional traffic are in such a nervous and mental state that they, whether motorists or pedestrians, are more likely to cause auto mishaps.

Table 1 presents the number of hours of restricted visibility (X), and the number of auto mishaps during these hours (Y), for the period under consideration. These data give a correlation coefficient of +0.84. The necessary data for a multiple correlation, with the flow of traffic as another variable, could not be obtained.

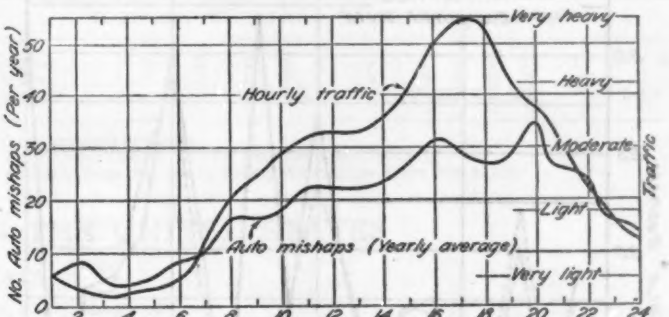


FIGURE 2.

The results of this study indicate that visibility restrictions are the actual cause of considerably more wrecks in Greensboro than is generally conceded:

(1) There is an increase of about 50 percent in the number of wrecks occurring during the times of restricted visibility as compared with periods of unrestricted visibility (based on actual records of the Greensboro Police Department and the U. S. Weather Bureau); as shown by figure 2, the ratio of wrecks to traffic is much higher

during the hours of restricted visibility (with a few minor exceptions).

(2) A surprisingly high correlation coefficient of +0.84 exists between the number of hours of restricted visibility and wrecks during these hours. It is realized that the proper interpretation of a correlation coefficient is one of the most difficult problems in the entire field of statistical analysis; however, it is generally accepted among statisticians that "coefficients above 0.70 give almost certain evidence of correlation, and any above 0.50 are ordinarily significant", and the above direct coefficient therefore indicates an actual correlation of the variables.

It therefore seems that visibility restrictions should be considered when studying the causes, and means of preventing, auto mishaps. It is the hope of the writer that this article will be of value in the fight being made by the press, civic clubs, and others to reduce the startling number of wrecks now occurring.

TABLE 1

	X	Y		X	Y
October 1930	170	21	November 1932	105	9
November 1930	199	26	December 1932	314	30
December 1930	147	17	January 1933	86	6
January 1931	109	5	February 1933	175	9
February 1931	147	16	March 1933	80	8
March 1931	139	9	April 1933	100	8
April 1931	151	15	May 1933	43	7
May 1931	89	13	June 1933	17	1
June 1931	27	1	July 1933	49	2
July 1931	37	3	August 1933	31	3
August 1931	71	7	September 1933	72	6
September 1931	19	3	October 1933	72	3
October 1931	98	7	November 1933	239	17
November 1931	385	21	December 1933	296	22
December 1931	222	16	January 1934	240	13
January 1932	183	30	February 1934	243	21
February 1932	205	18	March 1934	309	30
March 1932	181	11	April 1934	149	10
April 1932	121	7	May 1934	150	10
May 1932	138	6	June 1934	78	5
June 1932	62	9	July 1934	135	15
July 1932	24	1	August 1934	112	12
August 1932	16	5	September 1934	250	26
September 1932	84	5			
October 1932	128	12	Total	6,506	557

WEATHER AND PEARS IN NEW YORK STATE

By W. A. MATTICE

[Weather Bureau, Washington, January 1935]

Since the locale of the heaviest pear production in New York is concentrated in the Hudson Valley and the western lake sections, a group of stations was chosen in this region in order to cover the territory adequately. The data for the previous year's meteorological data were taken from the Climatological Data of the Weather Bureau and represent averages for the entire State. The weekly data were computed for selected stations in the

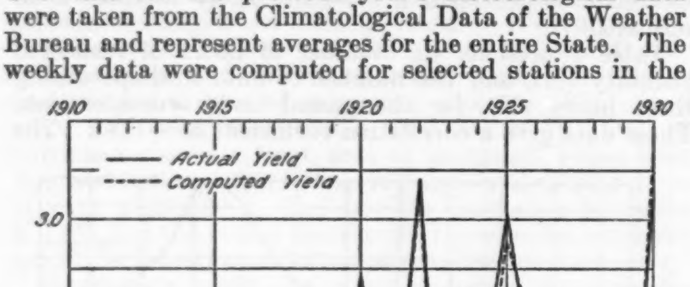


FIGURE 1.—Actual and computed production of pears in New York State.

areas of heaviest production, both regular Weather Bureau and cooperative stations. Sunshine data are for the regular Weather Bureau stations only.

The method used in computing the final correlation was that developed by Kincer [1] and scarcely needs further elaboration. The original single coefficients used in this study covered many phases of the weather, ranging from monthly mean temperatures for the State as a whole to weekly means of temperature, rainfall, and sunshine. Relative humidity was also used in the study, but no significant relationships were discovered. The total number of original coefficients was around 90, and out of this number 24 were selected as being of enough significance to use. The highest single coefficient used in the starting process was +0.59.

There are eight variables selected as the result of the trial computations, and the final multiple coefficient is +0.97. After the final computations of production by Kincer's method, a multiple coefficient was obtained following the method outlined by Wallace and Snedecor.[2] This gave the regression equation as follows:

$$X=57.95a+1.32b+13.74c-11.05d+9.35e+19.89f$$
$$+3.84g+1.84h-805.35$$

where X is the estimated yield and a is the weekly average rainfall for the week ending June 20; b is the weekly percent of possible sunshine for the week ending May 2; c is the State average rainfall for September of the preceding year; d is the monthly State rainfall for August of the preceding year; e is the monthly mean temperature for the State as a whole for June of the preceding year; f is the State average rainfall for May of the preceding year; g is the weekly mean temperature for the week ending March 14; and h is the weekly mean temperature for the week ending April 18.

Thus, the computations of production are all based on weather data well in advance of harvest. It is difficult to establish particular reasons for the significance of the various elements, except in a general way; for instance, the period of mean temperatures for the weeks of March 14 and April 18 may have some significance as regards blooming or setting. The rainfall of June 20 may be important as regards the sizing of the fruit. The previous year's data probably are significant as the fruit buds of the following year may depend largely on the weather when they are forming.

Figure 1 shows the actual and computed yields for the entire period, 1911–30. It will be seen readily that the weather is apparently a major factor as regards the production of pears. In the graph the last four ciphers of the production figures have been omitted for clarity in reproduction and also to facilitate computations in the actual work.

[1] Kincer, J. B., and Mattice, W. A. Statistical correlations of weather influence on crop yields. Mo. Wea. Rev., February 1928, vol. 56, p. 2.

[2] Wallace, H. A., and Snedecor, Geo. W. Correlation and machine calculation. Iowa State College, vol. 23, no. 35, Jan. 28, 1925.

PRELIMINARY REPORT ON TORNADOES IN THE UNITED STATES DURING 1934

By R. J. MARTIN

[Weather Bureau, Washington, January 28, 1935]

In keeping with the custom of recent years, a preliminary statement of loss of life and property damage by windstorms is here included in the December issue of the REVIEW. A final and more detailed study will appear in the report of the Chief of the Weather Bureau for the year 1934–35. Practically all the information given in this summary is abstracted from the monthly tables of "Severe Local Storms", which are compiled from the reports of many observers and various section directors of the Bureau. While it is thought the figures given are substantially correct, it must be remembered that all are subject to change after the final study mentioned above.

June, with 30 (possibly 34) tornadoes, was the month with the greatest number of such storms; but the total loss of life, 4, was less than in February, May, or October. July, with 17 (possibly 19) storms, was second, while February and November each had 12 tornadoes. The greatest loss of life occurred in February, when 20 persons were killed; 12 deaths were reported in Mississippi, caused by the two storms of the 25th, which are described on page 59, February, 1934, MONTHLY WEATHER REVIEW. Tornadoes caused the death of 8 persons during May, and 5 members of a C. C. C. camp were killed near Marysville, Mo., on the afternoon of October 23; several other deaths were caused by tornadic winds during May and October, including 5 persons who were burned to death in Laurel County, Ky., on the night of October 31.

June, with estimated tornado or tornadic wind damage of over $1,448,000, was also the month of greatest property loss. The second highest figure was $1,035,000 in October; over $900,000 of this was caused by the Marysville, Mo., storm (mentioned above) over a path 14 miles long, and 300 to 400 feet wide. The July storms resulted in losses of more than $955,600, most of which occurred on the 10th, at Jacksonville, Ill., and vicinity.

Tornadoes occurred without loss of life in March, April, July, and September. A child was fatally injured at Pensacola, Fla., on January 4, the only tornado death of that month. August also had one fatality; a man was killed in Wisconsin when his wagon was overturned by a tornadic wind. No tornadoes were reported in December.

The total number of tornadoes during the year, approximately 114, was 146 less than in the preceding year, and the least since 1931, when the total was 94. During March and May of 1933, 150 tornadoes occurred; the total for the corresponding months of 1934 was less than 30, even when tornadic winds and possible tornadoes are included. The total number of deaths resulting from the 1934 storms was 45, which is the least since 1931 (when only 36 deaths were caused by tornadoes) and the second lowest since 1916. Other than the Missouri and Mississippi storms mentioned above there were no unusually severe tornadoes during 1934, and both of these have been greatly exceeded in other years. In March of 1925, 689 deaths resulted from a single tornado, while on September 29, 1927, a tornado caused property damage in Missouri estimated at $25,000,000.

If further study shows the storms listed in the table of tornadic winds to be true tornadoes, the 1934 sums will be 140 tornadoes, 45 deaths, and property losses exceeding $5,713,300.

TORNADOES AND PROBABLE TORNADOES

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
Number	4	12	3	5	13	30	17	7	7	3	13	0	114
Deaths	1	20	0	0	8	2	0	0	0	5	4	----	40
Damage [1]	[2] 55	[2] 602	156.3	[2] 7	273	1,425	150.6	[2] 23	[2] 48	910	174.2	----	3,833.1

TORNADIC WINDS AND POSSIBLE TORNADOES [3]

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
Number	0	0	4	5	6	4	2	1	2	1	1	0	26
Deaths	----	------	0	0	1	2	0	1	0	1	0	----	5
Damage [1]	----	------	29	44.6	26.1	23	925	700	5.5	125	2	----	1,880.2

[1] In thousands of dollars.
[2] Additional damage occurred but no estimate secured.
[3] Some of these may not be classed as tornadoes in the final study.

THE WEATHER OF 1934 IN THE UNITED STATES

By R. J. MARTIN

[Weather Bureau, Washington, D. C., January 1935]

The widespread severe drought during the crop-growing season of 1934 was the outstanding feature of the year's weather. It began in the Northwest early in the spring, spread rapidly, and by the end of May had become the most extensive drought in the climatological history of the United States. In general by that date nearly three-fourths of the country was experiencing droughty conditions, which were most severe in the Ohio, central and upper Mississippi Valleys, the central and northern Plains, most Rocky Mountain sections, and the Great Basin. The drought is discussed in detail in the Report of the Chief of the Weather Bureau for the year 1933–34.

The year was abnormally warm nearly everywhere; only small areas in Michigan and North Carolina, and portions of New Jersey, New York, and New England averaged cooler than normal. The average for the entire year was 54.8°, giving a plus departure for the year of 2.5°. Precipitation was decidedly below normal; the deficiency, for all States, was 3.7 inches. State deficiencies were greatest in the Ohio Valley, and the central Plains States, and ranged from 11.37 inches in Ohio to 0.04 inch in New Jersey; 14 States had deficiencies of more than 5 inches. Ten of the forty-two climatic sections were wetter than normal, with excesses ranging from 0.20 inch in Oregon to 5.29 inches in Maryland-Delaware.

More temperature records were broken in 1934 than in any previous year of Weather Bureau history. For example, every station in Iowa established new high records for May except Glenwood, where the previous record was equaled; on the 31st every station in the State had a maximum of 100° or above. At many points in the interior valleys and the Northwest the May averages were higher than the June normal, and most central States reported one or more hottest months of record during the year. A few minimum temperature records (mostly seasonal) were broken in 1934; and some unusually cold weather occurred in Florida on December 12 and 13.

Extremes for the year were well within the previous records of −66° (February 1933) and 134° (July 1913). The lowest reported was −52° at Stillwater, N. Y., on February 9, with −51° noted at Vanderbilt, Mich., on the same date. All but 7 States had minima of zero or below, and in 27 States the minima were −20° or lower. The highest maximum reported was 125° at Greenland Ranch, Calif., on several days in July; Quartzsite, Ariz., had 124° on July 11. With the exception of Maine, New Hampshire, Vermont, and Rhode Island, all States had maxima of 100° or higher; in 12 States they exceeded 115°.

The summer of 1934 was by far the hottest of climatological history in a large midwestern area; at many points the excess was nearly double that of the previous record. At Columbia, Mo., and Oklahoma City, Okla., the average July maximum was 100°, and at Topeka, Kans., and Fort Smith, Ark., 102°. From June to August, inclusive, Des Moines, Iowa, had 22 days with maximum temperature of 100° or higher; Columbia, Mo., 34; Topeka, Kans., 47; Oklahoma City, Okla., 47; and Fort Smith, Ark., 53. The accumulated departures for the year at several outstanding stations were: Amarillo, Tex., 1,860°; Sheridan, Wyo., 1,983°; North Platte, Nebr., 2,099°; Miles City, Mont., 2,068°; Huron, S. Dak., 2,042°; and Pocatello, Idaho, 2,168°. Despite the hot weather of the summer, 13 States had minima of 32° or lower in July, and 20 States had such minima in August.

Table 1 shows that for the United States as a whole every month was warmer than normal, with the largest departures in January, May, and November. In January all sections were abnormally warm, with departures ranging from 1.4° in New England, to 11.7° over the northern slope (Montana, Wyoming, and western South Dakota and Nebraska). July and November were also above normal in all sections, but the departures were smaller. September was the nearest to normal, with a departure of only 0.1°. The largest negative departures occurred in February, mostly to east of the Mississippi River, and ranged from only 0.1° on the Florida Peninsula to 11.4° in the lower Lake region. Extreme variability in temperature during the year is shown by the fact that North Dakota had a plus departure of 11.3° for February. When sections, rather than stations, are considered the last column shows that only New England was cooler than normal for the year, and 7 months in that section were abnormally warm.

Table 2 shows that only September and November averaged above normal in precipitation for the entire United States; November was the relatively wettest month, with an excess of 0.8 inch. May and July were the driest, with deficiencies of 0.7 inch. No month had above-normal precipitation in North Dakota, and 6 of the districts listed in the table had only 2 months with above-normal precipitation. The largest annual deficiency, over 9 inches, occurred in the lower Lake region.

The spring of 1934 was the driest of record in the Dakotas, Minnesota, Nebraska, Iowa, and Illinois, and the second driest of record in Ohio, Indiana, Wisconsin, Missouri, and Kansas. The previous low records for this period were 40 percent to 70 percent greater than the 1934 totals. Rains in June, the first part of August, and early in September, with the cooler weather of the latter half of August, relieved droughty conditions, at least temporarily, over considerable areas.

During the year 1,106 stations reported at least 1 month with no precipitation, and 76 had months with totals of less than 0.01 inch. The greatest monthly total was 35.06 inches at Wynooche Oxbow, Wash., in January. This total was considerably exceeded by some stations in Alaska and Hawaii; Puohakamoa No. 2, Hawaii, measured 52 inches in April. Snowfall was variable in 1934, and was reported as far south as Georgia in April. California, Colorado, and Nevada had the least of record in March, and Maryland-Delaware had twice the normal that month. The total for April in California was only 3 percent of the normal. Three States had light snow in August; California had the heaviest September fall since 1901 over the northern and central Sierra Nevadas. September snows in Montana interrupted traffic, and in some areas remained on the ground for nearly a week. New December records were established in portions of Minnesota and Ohio, and light snow fell in portions of Florida in December.

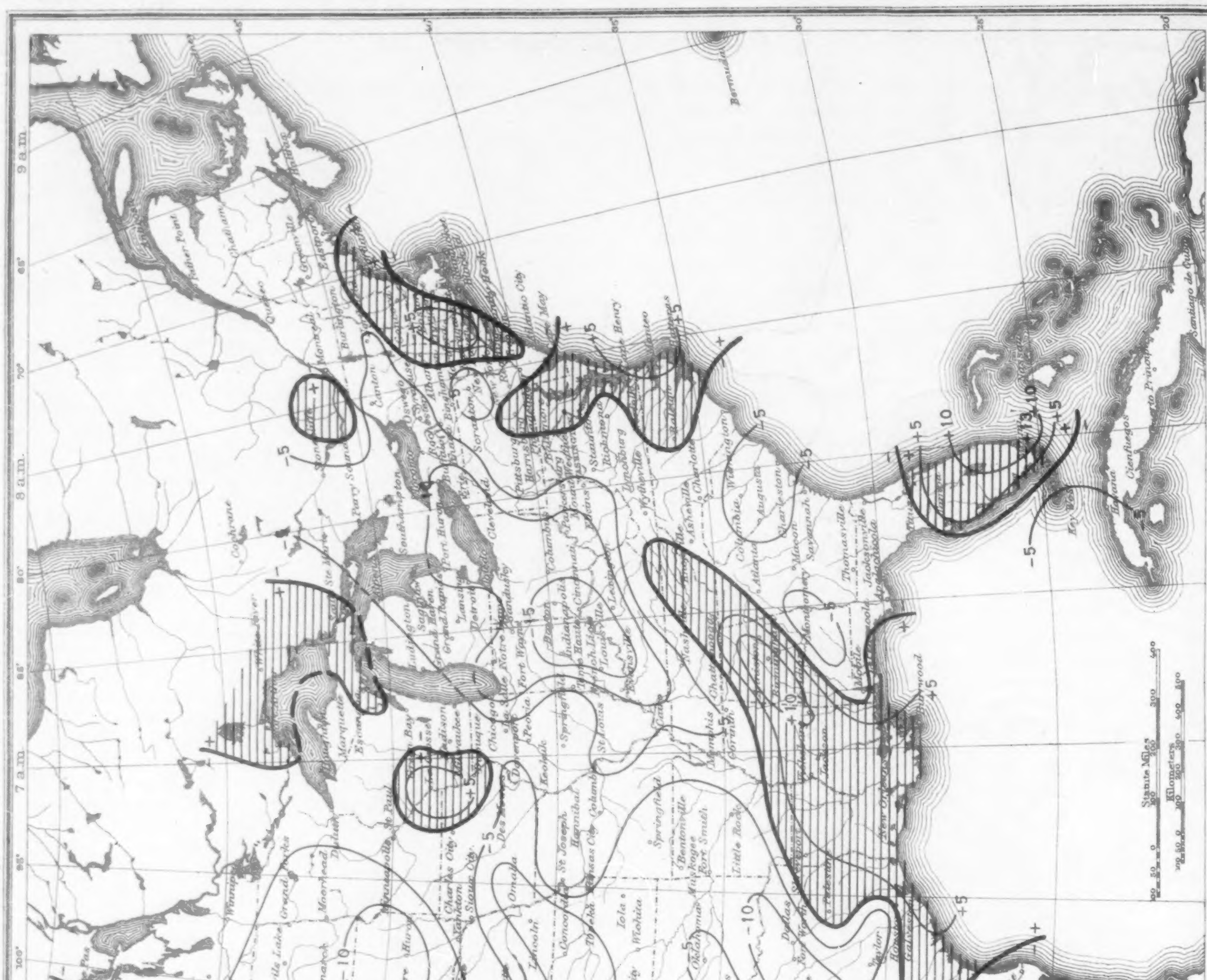
The accompanying charts based on reports from some 200 stations show temperature and precipitation departures in the United States for the year 1934. Floods, hurricanes, tornadoes, and other outstanding features of the year 1934 are discussed elsewhere in this issue of the REVIEW.

TABLE 1.—*Monthly and annual temperature departures, 1934*

District	January	February	March	April	May	June	July	August	September	October	November	December	Average
New England	+1.4	−10.7	−0.4	+1.5	+2.6	+1.3	+1.8	−2.0	+3.3	−2.4	+4.0	−3.2	−0.2
Middle Atlantic	+4.4	−10.6	−1.9	+.3	+1.8	+4.0	+2.7	−1.3	+2.4	−1.5	+3.9	−.5	+.3
South Atlantic	+3.6	−6.2	−1.5	+.7	−1.1	+2.1	+2.2	+1.5	+2.6	+.8	+2.7	−1.0	+.5
Florida Peninsula	+2.6	−.1	+.3	+1.2	+1.1	+.6	+.5	+.4	+.7	+2.2	+1.1	+.7	+.9
East Gulf	+3.7	−3.7	−1.5	+.8	.0	+1.7	+1.0	+1.1	+.3	+2.5	+3.0	−.8	+.7
West Gulf	+3.8	−.3	−2.6	+1.4	+.8	+3.6	+2.4	+3.0	−.5	+5.2	+4.4	+1.3	+1.9
Ohio Valley and Tennessee	+4.5	−7.4	−2.6	+.6	+2.5	+5.0	+4.3	+1.0	+.8	+1.3	+4.2	−1.1	+1.1
Lower Lakes	+4.0	−11.4	−2.3	−.4	+2.9	+4.5	+3.0	−1.3	+3.4	−1.2	+4.9	−2.8	+.3
Upper Lakes	+7.6	−5.9	−3.2	−.9	+4.7	+3.2	+1.7	−1.4	−.8	+1.5	+5.0	−2.4	+.8
North Dakota	+10.6	+11.3	+3.6	+2.7	+9.6	+1.4	+3.8	+1.8	−4.9	+5.6	+7.4	+.3	+4.4
Upper Mississippi Valley	+8.4	−.3	−1.8	+1.0	+7.7	+7.6	+5.2	+1.0	−2.7	+4.4	+6.0	−2.9	+2.8
Missouri Valley	+8.4	+4.2	−.2	+2.9	+8.1	+7.2	+8.4	+4.7	−3.9	+5.7	+5.5	−.6	+4.2
Northern Slope	+11.7	+9.5	+5.4	+5.4	+9.1	+2.0	+4.9	+2.7	−4.3	+5.6	+6.2	+1.6	+5.0
Middle Slope	+7.4	+3.6	+1.4	+3.0	+6.1	+6.4	+7.9	+5.5	−2.8	+6.3	+4.9	+1.8	+4.3
Southern Slope	+3.0	+2.8	−.2	+2.6	+2.8	+4.8	+3.7	+4.0	+1.2	+6.8	+5.0	+3.1	+3.3
Southern Plateau	+3.9	+5.4	+7.5	+6.2	+5.8	−.8	+3.0	+2.6	+2.0	+4.2	+1.9	+3.2	+3.7
Middle Plateau	+7.4	+7.9	+8.8	+7.3	+8.0	+.3	+3.8	+3.9	+.9	+4.1	+3.9	+2.9	+4.9
Northern Plateau	+10.5	+9.3	+8.0	+7.8	+6.5	+1.6	+2.5	+3.6	−.4	+4.0	+5.4	+2.4	+5.1
North Pacific	+5.9	+7.0	+7.2	+6.3	+4.7	+1.4	+.3	+2.0	+.9	+3.1	+3.9	+2.3	+3.8
Middle Pacific	+3.0	+3.6	+7.3	+5.4	+4.4	+1.8	+1.4	+2.0	+1.6	+1.5	+2.2	+1.4	+3.0
South Pacific	+2.5	+3.5	+7.3	+5.5	+4.5	−1.2	+1.2	+.2	+3.2	+1.8	+1.6	+2.9	+2.8
United States	+5.6	+.5	+1.8	+2.9	+4.4	+2.8	+3.1	+1.7	+.1	+2.9	+4.1	+.4	+2.5

I. Annual Temperature Departures (°F.) in the United States, 1934
(Plotted by R. J. Martin)

II. Annual Precipitation Departures (inches) in the United States, 1934
(Plotted by R. J. Martin)



Shaded portions show excess (+)
Unshaded portions show deficiency (−)

TABLE 2.—*Precipitation departures, monthly and annual, 1934*

District	January	February	March	April	May	June	July	August	September	October	November	December	Sum
New England	−0.2	+0.3	−0.2	+0.6	−0.5	+0.3	−1.2	−1.7	+2.1	−0.7	−0.4	−0.4	−2.0
Middle Atlantic	−1.0	−.1	+.7	−.4	+.6	−.3	−.3	−.5	+5.1	−1.7	+.4	−.8	+1.7
South Atlantic	−1.7	−.2	−.1	−.1	+2.2	.0	−1.7	−.4	+.8	−.2	+.8	−1.0	−1.6
Florida Peninsula	−.7	+1.5	−.2	+1.5	+4.0	+2.6	+1.2	−2.5	+.9	−2.6	−.7	−1.1	+3.9
East Gulf	−1.1	−.4	+.2	−.9	+.7	+.2	+.5	+.9	−1.9	+3.4	+.6	−1.9	+.3
West Gulf	+2.4	−.6	+2.1	+.5	−2.1	−2.9	−.7	−1.2	+1.0	−2.7	+2.3	−.2	−2.1
Ohio Valley and Tennessee	−1.6	−1.9	−.4	−1.7	−2.0	+.4	−.7	+.9	+1.2	−1.4	+.1	−1.2	−8.3
Lower Lakes	−.8	−1.3	.0	+.2	−2.5	−1.0	−1.2	−.8	+.5	−1.4	−.5	−.6	−9.4
Upper Lakes	−.4	−1.1	−.3	−.3	−1.8	−.8	−1.4	−.5	+.5	−.7	+2.5	−.4	−4.7
North Dakota	−.2	−.4	−.2	−1.1	−1.8	−.4	−1.5	−1.2	−.7	.0	−.5	−.2	−8.2
Upper Mississippi Valley	−.6	−.9	−.4	−1.6	−3.3	−1.2	+.4	−.4	+2.7	−.2	+3.6	−.4	−2.3
Missouri Valley	−.5	.6	−.6	−1.5	−1.9	−1.1	−2.0	−1.0	+1.5	−.6	+1.8	−.6	−7.1
Northern Slope	−.5	−.3	+.1	−.3	−1.7	.0	−.8	−.4	+.1	−.1	−.3	−.2	−4.4
Middle Slope	.0	+.5	−.5	−1.1	−1.1	−1.5	−1.9	−.8	+.5	−.7	+.7	−.4	−6.3
Southern Slope	−.4	−.4	+1.1	−.6	−.8	−1.6	−1.6	−1.5	−1.1	−1.2	+.3	−.5	−8.3
Southern Plateau	−.3	−.2	−.4	−.2	+.3	−.2	−.6	.0	−.2	−.4	+.2	+.1	−1.9
Middle Plateau	−.4	+.2	−.7	−.3	−.3	+.1	−.2	+.2	−.2	.0	+.4	.0	−1.2
Northern Plateau	−.5	−.6	−.1	−.6	−1.1	+.1	−.3	−.2	−.3	+.4	+.4	−.4	−3.2
North Pacific	+.5	−3.7	.0	−1.1	+.3	−.9	+.2	.0	−.6	+1.4	+2.2	+.6	−1.1
Middle Pacific	−3.3	−1.1	−2.3	−1.1	−.5	.0	.0	−.1	−.4	+.3	+1.8	−.5	−7.2
South Pacific	−1.0	−.3	−2.0	−.9	−.4	+.2	.0	.0	.0	+.9	+1.4	+1.0	−1.1
United States	−.6	−.6	−.2	−.5	−.7	−.4	−.7	−.5	+.5	−.4	+.8	−.4	−3.7

TROPICAL STORMS OF 1934

By G. E. DUNN

Eleven tropical disturbances were reported this year in the Atlantic, Caribbean Sea, and the Gulf of Mexico. While six of these probably reached hurricane intensity, no especially intense hurricane reached the coast of the United States. Two storms either crossed or reached the Texas coast and one crossed the Louisiana coastline, all of which were barely of hurricane intensity. An examination of the storm paths on the following page reveals some unusual tracks. Storms 2 and 5 were especially erratic and no. 3 started as an extratropical storm off the coast of South Carolina.

Monthly frequency of West Indian hurricanes and other tropical storms of the North Atlantic Ocean in 1934

	Hurricane intensity	Doubtful	Not of hurricane intensity	Total
May	0	0	1	1
June	1	0	0	1
July	0	1	0	1
August	1	0	1	2
September	1	0	1	2
October	1	0	2	3
November	1	0	0	1
Total	5	1	5	11

Synopsis of tropical storms of 1934 (number of storm in table corresponds with number of track on accompanying chart)

Storm	Date	Place where first reported	Coast lines crossed	Maximum wind velocity reported	Lowest barometer reported	Place of dissipation	Intensity	Remarks
1	May 27–30	Southeastern Gulf of Mexico.[1]	Between Charleston, S. C., and Savannah, Ga.	53–SE., Charleston	29.17, Savannah	Northwestern South Carolina.	Not of hurricane intensity.	Damage $155,000.
2	June 4–23	Gulf of Honduras [1]	British Honduras (probably twice) and Louisiana.	Steamship *Belfast Maru*, 70–SSE.	28.52, Jeanerette, La.	Passed beyond field of observation.	Hurricane	(A).
3	July 21–25	On South Carolina coast.[1]	Between Corpus Christi and Freeport, Tex.	52–S., Corpus Christi.	29.12, Corpus Christi.	Northern Mexico	Doubtful, but near hurricane intensity.	(B).
4	Aug. 20–22	East of Dominica [1]	None			South of Santo Domingo.	Very minor	
5	Aug. 26–Sept. 1.	Middle Gulf [1]	Mexico, north of Tampico.	Steamships *Clare* and *Simon von Utrecht*, hurricane.	29.34, steamship *Simon von Utrecht*.	Mexico	Barely hurricane intensity short period.	(C).
6	Sept. 5–9	Eastern Bahamas [1]	Touched Cape Hatteras and passed over Long Island Sound.	Hurricane force from many ships.	28.56, steamship *Albert Watts*.	Northern New England.	Hurricane	
7	Sept. 15–21	Short distance east of Windward Islands.[1]	None	50 NE., steamship *Selene*.		Off Middle Atlantic coast.	Not of hurricane intensity.	
8	Oct. 1	Latitude 28:40, longitude 42:20.[2]	None	Steamship *Selene*, Hurricane.	29.06, steamship *Selene*.	North Atlantic	Hurricane	Recurved east of longitude 50.
9	Oct. 3–5	Southeastern Gulf of Mexico.[1]	Near Pensacola, Fla.	38–S., Pensacola	29.65, steamship *Del Sud*.	Northwestern Florida.	Minor	Record rain, Pensacola.
10	Oct. 19–23	South of Jamaica [1]	Eastern Cuba			Near Bermuda	Very minor	
11	Nov. 21–28	North of Leeward Islands.	None	Steamship *Malacca*, hurricane.	28.20, steamship *Malacca*.	Haiti	Hurricane	

[1] Approximate place of origin.
[2] Well developed when first appeared in field of observation.

(A) More complete report M. W. R., 62:202–203. June 1934.
(B) More complete report M. W. R., 62:251. July 1934.
(C) More complete report M. W. R., 62:344. September 1934.

BIBLIOGRAPHY

C. FITZHUGH TALMAN, *in charge of Library*

RECENT ADDITIONS

The following have been selected from among the titles of books recently received as representing those most likely to be useful to Weather Bureau officials in their meteorological work and studies:

American national red cross
Hurricane disasters of August and September 1933. Washington. 1934. 41 p. illus. tables. 23 cm.

Hettner, Alfred
Vergleichende Länderkunde. Leipzig und Berlin, B. G. Teubner, 1933–34. Band III. "Die Gewässer des Festlandes. Die Klimate der Erde." illus. (incl. maps), diagrs. 23½ cm.

Ridgley, Douglas Clay
Rainfall of the earth. Bloomington, Ill., McKnight & McKnight, 1933. 47 p. illus. 19½ cm. (Important topics in geography.)

Shaw, Sir William Napier
The drama of weather. New York, The Macmillan company; Cambridge, England, The University press, 1933. xiv, 269 p. front., illus. (incl. charts), diagrs. 21 cm. Printed in Great Britain.

Smythe, Francis Sydney
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Somme. Commission météorologique
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SOLAR OBSERVATIONS

SOLAR RADIATION MEASUREMENTS DURING DECEMBER 1934

By IRVING F. HAND, Assistant in Solar Radiation Investigations

For a description of instruments employed and their exposures, the reader is referred to the January 1932 REVIEW, page 26.

Table 1 shows that solar radiation intensities at normal incidence averaged above normal for December at Washington and Madison, and close to normal at Lincoln.

Table 2 shows an excess in the total solar and sky radiation received on a horizontal surface at Chicago, New York, Twin Falls, Miami, and New Orleans, and a deficiency at all other stations for which normals have been computed. A marked excess of radiation for the year was received at all stations with the exception of Pittsburgh, which was close to normal, and Madison and Miami, both of which were considerably below normal.

The December turbidity measurements at Washington are noteworthy because of the large water-vapor content on all clear days except the 12th.

Polarization measurements obtained at 5 days at Washington give a mean of 54 percent with a maximum of 64 percent on the 5th. Both of these values are close to their respective December normals. No polarization readings were made at Madison owing to continuous snow and ice coverage.

TABLE 1.—*Solar radiation intensities during December 1934*

[Gram-calories per minute per square centimeter of normal surface]

WASHINGTON, D. C.

Date	Sun's zenith distance										
	8 a. m.	78.7°	75.7°	70.7°	60.0°	0.0°	60.0°	70.7°	75.7°	78.7°	Noon
	75th mer. time	Air mass A. M.					P. M.				Local mean solar time
	e	5.0	4.0	3.0	2.0	* 1.0	2.0	3.0	4.0	5.0	e
	mm	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	mm
Dec. 5	2.74				1.36			1.20	1.03	0.92	2.74
Dec. 11	1.88				1.20						1.88
Dec. 12	1.68			1.03							1.78
Dec. 14	2.36	0.92	0.98	1.05	1.30			1.20	1.08	1.01	2.36
Dec. 15	2.87	.71	.88	.99							2.62
Dec. 18	3.00	1.01	1.12	1.17	1.21						3.00
Means		.88	.99	1.06	1.24			(1.20)	(1.06)	(.96)	
Departures		+.09	+.08	+.01	+.00			+.16	+.15	+.16	

TABLE 1.—*Solar radiation intensities during December 1934*—Con.

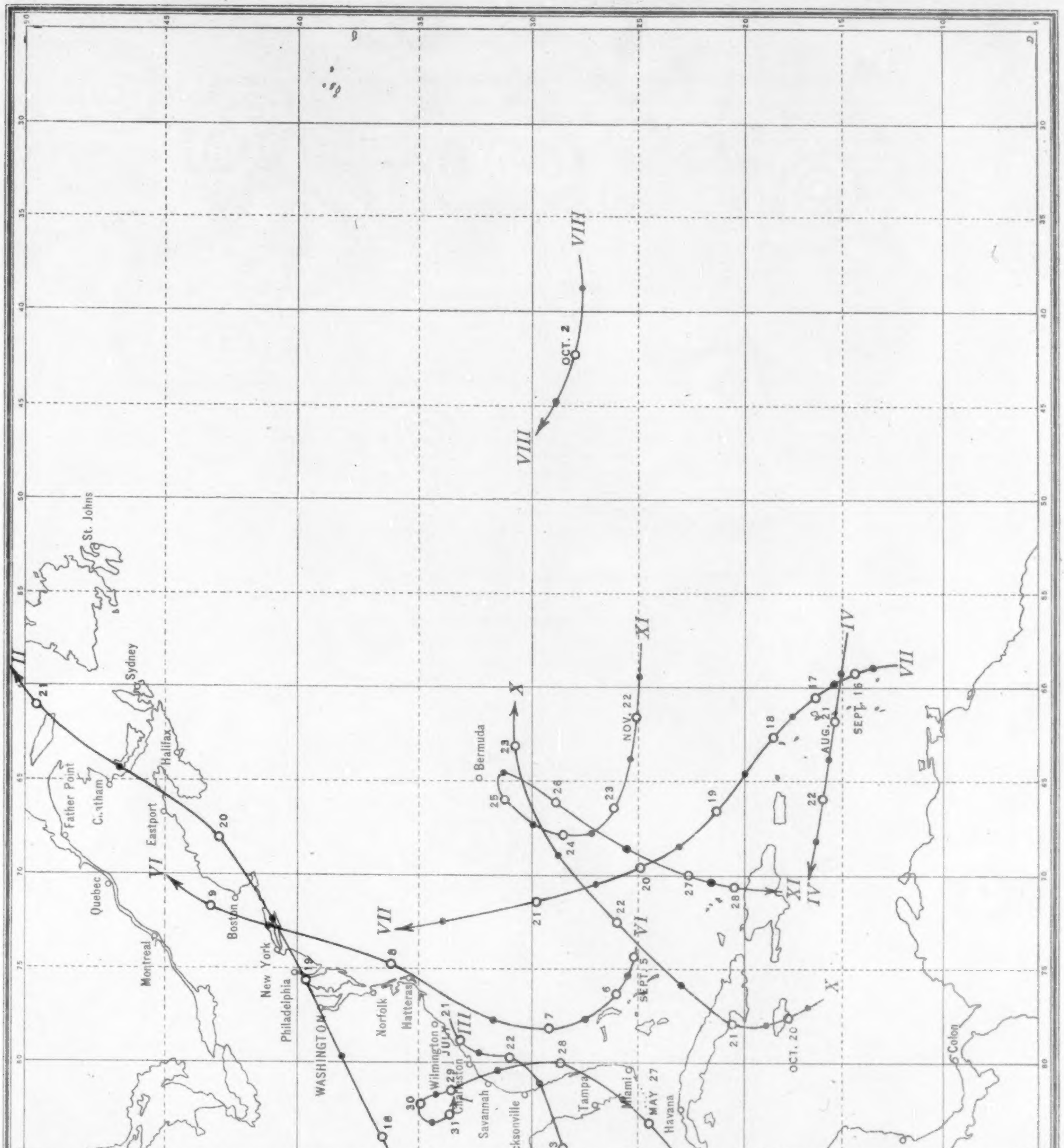
[Gram-calories per minute per square centimeter of normal surface]

MADISON, WIS.

Date	Sun's zenith distance										
	8 a. m.	78.7°	75.7°	70.7°	60.0°	0.0°	60.0°	70.7°	75.7°	78.7°	Noon
	75th mer. time	Air mass A. M.					P. M.				Local mean solar time
	e	5.0	4.0	3.0	2.0	* 1.0	2.0	3.0	4.0	5.0	e
	mm	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	mm
Dec. 6	1.68							1.31			1.88
Dec. 7	1.37		1.20	1.34							1.52
Dec. 10	1.96	1.16	1.22	1.34							1.60
Dec. 11	1.88	1.04		1.15							1.45
Dec. 13	2.36							1.30			2.87
Dec. 17	2.87							1.10			2.49
Dec. 26	.66			1.38							.51
Means		(1.16)	(1.21)	1.30				1.24			
Departures		+.20	+.12	+.08				+.01			
LINCOLN, NEBR.											
Dec. 3	2.26							1.25			2.36
Dec. 4	2.26	1.03	1.14	1.30				1.29	1.19	1.08	2.87
Dec. 7	.96							1.26	1.12	1.01	1.19
Dec. 11	1.02							1.21	1.04	.97	2.62
Dec. 12	3.00	1.06	1.15	1.28				1.20	1.00		4.17
Dec. 15	4.37			1.02				1.20	1.08	.95	5.16
Dec. 19	1.96	1.13	1.21	1.34				1.15			2.36
Dec. 20	3.81	.81	1.00	1.20							4.37
Dec. 26	.48	.92	1.07	1.23				1.07			4.17
Dec. 27	2.36	.66	.86	1.09				1.10	.96	.82	3.81
Means		.94	1.07	1.21				1.19	1.06	.97	
Departures		+.01	+.01	−.01				−.01	−.01	+.01	
BLUE HILL, MASS.											
Dec. 2	3.3						1.25	1.04	0.95	0.83	3.5
Dec. 3	3.2	1.00	1.10	1.23							2.2
Dec. 4	6.5			1.07							6.5
Dec. 5	2.9		1.08	1.23	1.42			1.19			2.3
Dec. 8	1.2			1.20	1.32						1.1
Dec. 9	1.0			1.31	1.42			1.27			1.1
Dec. 11	1.0	1.01	1.12	1.24	1.36			1.24			1.0
Dec. 12	1.3		1.22	1.31	1.42			1.22			1.3
Dec. 14	1.3		1.20	1.29	1.44			1.24			2.1
Dec. 15	1.0		1.23	1.33	1.45			1.28			1.0
Dec. 18	1.2		1.26	1.35	1.40			1.31			1.3
Dec. 20	3.5			1.06	1.28			1.23		1.02	2.6
Dec. 27	.6	1.18	1.20	1.27	1.42			1.27			.6
Dec. 30	1.0	1.06	1.16	1.28	1.45			1.32			1.1
Dec. 31	1.0	1.12	1.27	1.35	1.46			1.31			.7
Means		1.07	1.18	1.25	1.40		(1.25)	1.24	(.95)	(.92)	

* Extrapolated.

Paths of Hurricanes and Other Tropical Storms, 1934
(Approximate position at each observation hour)
(Plotted by Arthur J. Haidle)



DEC

Dec.
Dec.
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TAB

0:54

2:14
2:06

2:11
2:07
0:31
0:27

3:05
3:01
2:26
2:21
2:05
2:01

2:26
0:48
0:44

TABLE 2.—*Average daily totals of solar radiation (direct+diffuse) received on a horizontal surface*

Week beginning—	Washington	Madison	Lincoln	Chicago	New York	Fresno	Pittsburgh	Fairbanks	Twin Falls	Miami	New Orleans	Riverside	Blue Hill	Friday Harbor
	Gram-calories per square centimeter													
1934	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*
Dec. 3	160	126	169	67	164	218	52	3	129	209	209	210	197	122
Dec. 10	137	119	134	91	144	160	----------	4	164	369	270	136	182	44
Dec. 17	87	92	166	145	80	112	----------	11	147	254	223	254	134	44
Dec. 24 [1]	136	105	146	87	128	159	----------	10	129	286	154	224	158	72
	Departures from weekly normals													
Dec. 3	0	+12	−9	−1	+66	+26	−35	−14	+11	−1	−2	----------	----------	----------
Dec. 10	−4	+6	−35	+13	+50	−10	----------	−2	+53	+70	+74	----------	----------	----------
Dec. 17	−58	−27	−16	+56	−13	−38	----------	+5	+31	−29	+44	----------	----------	----------
Dec. 24	−12	−17	−36	+2	+18	+18	----------	+4	−7	+3	+7	----------	----------	----------
	Accumulated departures on—													
	+1,668	−3,461	+5,363	----------	+14,242	+8,481	+358	+410	+6,454	−7,459	+7,092	----------	----------	----------
	Percentage departures at end of year													
	+1.3	−2.9	+1.9	----------	+14.8	+5.2	+0.3	+0.3	+4.4	−4.7	+6.3	----------	----------	----------

[1] 8-day mean.

TABLE 3.—*Total, I_m, and screened, I_y, I_r, solar radiation intensity measurements, obtained during December 1934, and determinations of the atmospheric turbidity factor, β, and water-vapor content, w=depth in millimeters, if precipitated*

AMERICAN UNIVERSITY, WASHINGTON, D. C.

Date and hour angle	Solar altitude		Air mass	I_m	I_y	I_r	$\beta_{I_{m-r}}$	$\beta_{I_{y-r}}$	β_{mean}	$\frac{I_{w=0}}{1.94}$	$\frac{I_{w=0}-I_m}{1.94}$	w	Air-mass type
										Percentage of solar constant			
Dec. 5, 1934	°	′	*m*	*gr. cal.*	*gr. cal.*	*gr. cal.*						*mm*	
0:54 a. m.	27	30	2.16	1.354	0.976	0.792	0.026	0.020	0.023	70.8	12.0	15.8	N_{PP} or N_{PC}
Dec. 12, 1934													
2:14 a. m.	20	34	2.82	1.057	.791	.661	.066	.072	.069	62.7	10.0	5.1	P_C
2:06 a. m.	21	24	2.72	1.042	.791	.661	.078	.075	.076	61.7	9.8	5.0	
Dec. 14, 1934													
2:11 a. m.	20	47	2.99	1.135	.849	.675	.035	.015	.025	72.4	15.8	----------	P_P
2:07 a. m.	21	12	2.75	1.153	.852	.676	.032	.018	.025	74.0	16.5	----------	
0:31 a. m.	27	28	2.16	1.292	.932	.757	.038	.034	.036	76.0	11.7	14.2	
0:27 a. m.	27	35	2.15	1.294	.922	.757	.037	.035	.036	76.1	10.7	9.3	
Dec. 15, 1934													
3:05 a. m.	14	16	4.00	.859	.681	.563	.066	.050	.058	57.4	14.7	24.9	P_C
3:01 a. m.	14	48	3.86	.859	.681	.563	.068	.056	.062	57.4	14.7	25.8	
2:26 a. m.	19	05	3.03	.999	.778	.654	.084	.068	.076	58.7	9.3	2.6	
2:21 a. m.	19	46	2.94	1.034	.780	.656	.070	.070	.070	61.4	9.8	4.6	
2:05 a. m.	21	20	2.74	1.043	.792	.637	.064	.038	.051	66.6	16.6	----------	
2:01 a. m.	21	41	2.69	1.070	.794	.638	.044	.040	.042	69.8	15.4	----------	
Dec. 18, 1934													
2:26 a. m.	17	50	3.24	1.186	.881	.728	.022	.024	.023	72.4	13.2	16.4	P_C
0:48 a. m.	26	46	2.21	1.195	.877	.701	.048	.023	.036	74.0	14.6	----------	
0:44 a. m.	26	55	2.20	1.168	.879	.703	.068	.024	.046	73.0	15.0	----------	

Atmospheric conditions during turbidity measurements

Dec. 5: Temperature, 2° C; wind, NW. 12; visibility, 50 miles; polarization, 64 percent; blueness of sky, 6.
Dec. 12: Temperature, −5° C.; wind, NW. 14; visibility, 12 miles; polarization, 42 percent; blueness of sky, 4.
Dec. 14: Temperature, 0° C.; wind, NW. 15; visibility, 20 miles; polarization, 57 percent; blueness of sky, 5.
Dec. 15: Temperature, −1° C.; wind, NW. 10; visibility, 20 miles; polarization, 55 percent; blueness of sky, 5.
Dec. 18: Temperature, 0° C.; wind, NW. 8; visibility, 30 miles; polarization, 54 percent; blueness of sky, 5.

TABLE 3.—*Total, I_m, and screened, I_y, I_r, solar radiation intensity measurements, obtained during December 1934, and determinations of the atmospheric turbidity factor, β, and water-vapor content, w=depth in millimeters, if precipitated*—Continued

Date and hour angle from apparent noon	Solar altitude		Air mass	I_m	I_y	I_r	β_{I_m-r}	β_{I_y-r}	β_{mean}	$\frac{I_{w=0}}{1.94}$	$\frac{I_{w=0}-I_m}{1.94}$	w	Air-mass type
										Percentage of solar constant			
Dec. 2, 1934	°	′	m	gr. cal.	gr. cal.	gr. cal.						mm	
0:21 a. m.	25	24	2.30	1.174	0.870	0.721	0.076	0.086	0.081	68.9	5.1	1.1	N_P, T_C aloft.
0:14 a. m.	25	43	2.30	1.182		.710	.062		.062	68.7	9.1	6.9	N_P, T_C aloft.
Dec. 4, 1934													
1:59 p. m.	19	55	2.92	.887	.680	.579	.102	.148	.125	50.3	5.9	1.5	N_{PC}, T_C aloft
Dec. 5, 1934													
2:47 a. m.	14	49	3.86	1.097	.844	.704	.049	.050	.050	61.0	6.6	1.3	P_C
1:25 a. m.	22	32	2.60	1.295	.951	.780	.036	.038	.037	72.1	7.3	2.9	
1:13 a. m.	23	17	2.52	1.310	1.014	.793	.047	.046	.046	70.3	4.7	2.6	
0:20 a. m.	25	16	2.33	1.360	.987	.810	.036	.054	.045	72.2	4.1	2.6	
0:20 p m.	25	16	2.33	1.370	.997	.815	.033	.054	.044	72.5	3.9	2.4	P_C
1:50 p. m.	20	42	2.81	1.257	.930	.763	.033	.033	.033	71.8	8.9	5.2	
Dec. 8, 1934													
1:21 a. m.	24	50	2.37	1.271	.947	.783	.058	.061	.060	68.5	4.9	2.1	P_C
Dec. 9, 1934													
1:08 a. m.	23	07	2.54	1.347	1.010	.835	.045	.049	.047	70.0	2.9	2.2	
0:11 a. m.	24	56	2.36	1.380	1.032	.866	.052	.050	.051	70.5	1.5	1.2	P_C
0:09 p. m.	24	57	2.36	1.371	1.015	.851	.049	.064	.056	70.3	1.7	1.5	P_C
Dec. 11, 1934													
2:23 a. m.	16	50	3.43	1.186	.901	.771	.049	.063	.056	61.1	1.8	1.1	P_C
0:33 a. m.	24	21	2.42	1.312	.971	.811	.050	.065	.058	68.5	2.9	1.1	
0:24 p. m.	24	33	2.40	1.317	.983	.806	.048	.046	.047	70.7	4.5	2.2	
Dec. 12, 1934													
0:13 a. m.	24	40	2.38	1.401	1.035	.842	.030	.025	.028	71.2	6.2	3.0	
0:15 p. m.	24	37	2.39	1.391	1.017	.851	.037	.062	.050	70.6	1.1	1.3	P_C; N_{PP} aloft
1:25 p. m.	21	50	2.68	1.330	.989	.819	.037	.044	.040	70.6	3.1	2.0	
Dec. 14, 1934													
2:08 a. m.	18	21	3.16	1.266	.974	.834	.054	.058	.056	67.3	3.6	1.6	P_C
1:37 a. m.	20	47	2.80	1.313	.996	.834	.047	.051	.049	67.6	2.0	1.9	
0:57 a. m.	23	12	2.53	1.349	.992	.821	.043	.049	.046	71.2	3.8	2.2	
0:36 a. m.	23	00	2.45	1,368	.998	.823	.033	.044	.038	74.1	5.7	2.7	
Dec. 15, 1934													
2:38 a. m.	15	04	3.79	1.266	.976	.833	.035	.045	.040	63.6	3.2	1.1	P_C
2:16 a. m.	17	13	3.35	1.313	.996	.838	.028	.039	.044	65.0	1.7	1.1	
0:18 a. m.	24	23	2.41	1.373	1.006	.836	.034	.051	.042	72.5	3.9	2.4	
0:16 p. m.	24	26	2.41	1.360	.999	.827	.040	.054	.047	70.7	2.7	2.2	
2:00 p. m.	18	56	3.06	1.240	.957	.788	.068	.031	.050	68.0	3.0	1.8	P_C
Dec. 18, 1934													
2:50 a. m.	13	18	4.28	1.237	.960	.808	.026	.029	.028	67.1	5.4	1.7	P_C
2:29 a. m.	15	55	3.61	1.280	.970	.805	.023	.022	.022	70.3	6.4	2.0	
1:46 a. m.	19	58	2.90	1.369	.994	.813							
0:10 a. m.	24	22	2.41	1.363	.995	.813	.035	.027	.031	75.4	7.4	3.1	
0:11 p. m.	24	21	2.42	1.366	.998	.810	.030	.032	.031	75.3	7.2	2.2	
Dec. 27, 1934													
2:35 a. m.	15	24	3.72	1.200	.923	.779	.044	.047	.046	62.1	2.3	1.9	P_C
2:13 a. m.	17	42	3.26	1.255	.946	.789	.037	.045	.041	66.3	3.7	1.8	
0:33 a. m.	24	00	2.45	1.384	1.002	.829	.030	.048	.039	72.9	4.1	2.6	
0:09 a. m.	24	25	2.41	1.379	.998	.814	.027	.033	.030	75.3	6.6	2.6	
1:41 p. m.	20	21	2.86	1,283	.948	.778	.028	.040	.034	71.0	7.2	2.6	P_C
Dec. 30, 1934													
2:43 a. m.	14	33	3.94	1.171	.808	.762	.043	.050	.046	61.2	2.8	1.4	P_C
2:21 a. m.	16	57	3.41	1.220	.937	.789	.042	.038	.040	65.7	4.8	2.0	
0:46 a. m.	23	32	2.50	1.384	1.019	.831	.030	.032	.031	74.5	5.5	2.7	
0:18 a. m.	24	28	2.40	1.384	1.019	.831	.037	.035	.036	73.1	4.1	2.5	P_C
Dec. 31, 1934													
2:44 a. m.	14	31	3.94	1,273	.984	.827	.027	.028	.028	61.7	3.2	1.4	P_C
2:21 a. m.	17	12	3.35	1,328	1.012	.855	.053	.057	.055	67.0	1.8	1.5	
1:13 a. m.	22	32	2.60	1,409	1.030	.855	.027	.040	.034	73.0	2.8	2.0	
0:28 a. m.	24	26	2.41	1.414	1.047	.863	.036	.037	.036	75.0	4.5	2.7	
0:05 a. m.	24	40	2.38	1,424	1.050	.870	.035	.043	.039	73.4	2.4	2.1	
1:42 p. m.	20	34	2.82	1.349		.828	.026		.026	73.1	5.9	2.1	P_C

Atmospheric conditions during solar radiation measurements, Blue Hill Meteorological Observatory of Harvard University

Date and time from apparent noon	Air temperature	Wind (Beaufort scale)	Visibility; scale, 0-10	Sky blueness	Clouds and remarks
December 1934	°C.				
2; 0:45 a. m.	6.7	W 5	8+	9	4 Cu, Frcu, Stcu.
2; 2:21 p. m.	6.9	W 5	8+	6	Few Ci, Cist; 2 Frcu, Cu.
3; 3:34 a. m.	−16.1	NW 2	8	7	3 Ci, Few Acu.
4; 1:30 p. m.	5.0	NWxW 3	8	5	2 Acu, 1 Cu; moist haze.
4; 3:09 p. m.	8.3	W 6	9		Few Ci, 2 Acu, 1 Cu; lt. hz. Clouds 6° from sun.
5; 3:10 a. m.	2.1	WNW 6	9	9	Few Acu, few Frcu. Mount Monadnock completely visible.
5; 1:53 a. m.	3.3	WNW 6	9	10	Few Cu, Frcu.
5; 0:06 a. m.	4.4	NW 5	9		1 Cu, Frcu.
5; 1:51 p. m.	4.2	WNW 6	9	6	1 Cu.
8; 1:41 a. m.	−12.9	NW 5	8	7	1 Ci, Cist.
9; 0:23 a. m.	−12.2	WNW 3	9	6	6 Ci, Cist.
9; 2:39 p. m.	−9.2	NW 3	9	8	Few Cist.
11; 2:28 a. m.	−13.9	NNW 4	8	8	Few Stcu; moderate haze.
11; 0:07 a. m.	−11.9	NW 4	8-9	8	Light haze.
12; 3:18 a. m.	−10.7	NW 4	8-9	10	Few Ci. lt. haze to 3° alt.
12; 0:17 a. m.	−7.1	NW 3	9	10	Lt. haze to 3° alt.
12; 1:19 p. m	−4.9	WNW 3	8-9	12	Lt. haze to 3° alt.
12; 3:20 p. m.	−3.2	WNW 3	8-9	6	3 Ci. in west.
14; 2:18 a. m.	−8.3	WNW 4	8-9	8	Lt. haze.
14; 1:08 a. m.	−4.4	W 4	8-9	10	2 Ci, Cicu; light haze.
15; 2:47 a. m.	−12.2	WNW 5	7-9	8	Few Cist, Frcu.
15; 0:10 a. m.	−8.9	WxN 5	8	8	Cist. 5° of sun; lt. haze.
18; 2:56 a. m.	−8.3	NW 6	9-10	10	0 clouds.
18; 1:26 a. m.	−4.6	NW 4	9	11	0 clouds.
18; 0:09 a. m.	−4.4	NW 5	8-9	10	0 clouds.
18; 2:39 p. m.	−0.6	NW 3	8-9	10	Few Ci, Cist; lt. haze.
20; 2:19 a. m.	2.2	W 8	7	6	6 Stcu, Frcu. Heavy water haze.
20; 0:27 a. m.	1.9	W 10	8-9	6	5 Cu, Frcu.
20; 3:54 p. m.	1.3	W 8	9	8	Few Cu.
24; 2:34 a. m.	±0.0	W 5	6	4	2 Cist, Cicu; heavy water haze.[1]
27; 2:33 a. m.	−11.1	WNW 8	9		0 clouds; light haze.
27; 0:32 a. m.	−10.6	WNW 7	9	4	Few Ci. on horizon.
27; 1:51 p. m.	−8.3	WNW 7	9		Few Ci.
30; 2:37 a. m.	−12.8	WxN 6	7-9	6	Few Frcu; no haze.
30; 0:36 a. m.	−10.0	WNW 7	8-9	6	Few Cu; no haze.
30; 3:31 p. m.	−7.8	NW 7	9	6	Few Ci; no haze.
31; 2:27 a. m.	−10.3	WNW 6	8-9	4	0 Clouds; light haze.
31; 0:21 a. m.	−5.6	NW 5	9	6	0 clouds; light haze.

[1] From this date, on blue sky observations made with comparison card shielded from direct rays of the sun.

POSITIONS AND AREAS OF SUN SPOTS

[Communicated by Capt. J. F. Hellweg, U. S. Navy, Superintendent U. S. Naval Observatory. Data furnished by the U. S. Naval Observatory in cooperation with Harvard and Mount Wilson Observatories. The difference in longitude is measured from the central meridian, positive west. The north latitude is positive. Areas are corrected for foreshortening and are expressed in millionths of the sun's visible hemisphere. The total area for each day includes spots and groups]

Date	Eastern standard time		Heliographic: Diff. in longitude	Longitude	Latitude	Area: Spot	Group	Total area for each day	Observatory
1934	h	m	°	°	°				
Nov. 1	13	18	−73.0	161.3	+23.5		201	201	U. S. Naval.
Nov. 2	13	29	−58.5	162.5	+23.0		216	216	Do.
Nov. 3	11	7	−45.5	163.7	+23.0		139	139	Do.
Nov. 4	12	52	−32.0	163.0	+23.0		93	93	Do.
Nov. 5	11	18	−18.5	164.2	+23.0		69	69	Do.
Nov. 6	11	16	−6.0	163.5	+23.0		54	54	Do.
Nov. 7	11	18	+11.0	167.3	+22.0	35		35	Do.
Nov. 8	14	22	+26.0	167.4	+22.0	31		31	Do.
Nov. 9	11	42	+39.5	169.2	+22.0	31		31	Do.
Nov. 10	11	2	+53.5	169.9	+23.5	91		91	Harvard.
Nov. 11	14	4	+65.0	167.1	+22.0	10		10	U. S. Naval.
Nov. 12	11	8		No spots					Do.
Nov. 13	13	28		No spots					Do.
Nov. 14				No spots					Harvard.
Nov. 15	11	7		No spots					U. S. Naval.
Nov. 16	11	15		No spots					Do.
Nov. 17	11	29		No spots					Do.
Nov. 18	12	19		No spots					Do.
Nov. 19	11	21		No spots					Do.
Nov. 20	11	7		No spots					Do.
Nov. 21	12	0		No spots					Mount Wilson.
Nov. 22	13	40		No spots					U. S. Naval.
Nov. 23	11	0		No spots					Mount Wilson.
Nov. 24	11	14		No spots					U. S. Naval
Nov. 25	11	42		No spots					Do.
Nov. 26	12	45	−1.0	264.1	−34.0		16	16	Mount Wilson.
Nov. 27	18	30	+12.0	260.7	−20.0		15		Do.
			+16.0	264.7	−35.0		7	22	
Nov. 28	12	50	+23.0	261.7	−19.0		20		Do.
			+39.0	277.7	−20.0		210	230	
Nov. 29	12	15	+14.0	239.8	−27.0		52		Do.
			+38.0	263.8	−19.0		21		
			+52.0	277.8	−20.0		116	189	
Nov. 30	12	10	+28.0	240.6	−28.0		93		Do.
			+51.0	263.6	−20.0		36		
			+65.0	277.6	−21.0		46	175	
Mean daily area for 30 days								53	

POSITIONS AND AREAS OF SUN SPOTS—Continued

Date	Eastern standard time		Heliographic: Diff. in longitude	Longitude	Latitude	Area: Spot	Group	Total area for each day	Observatory
1934	h	m	°	°	°				
Dec. 1	12	40	+40.0	239.2	−28.0		31		Mount Wilson.
			+65.0	264.2	−20.0	12			Do.
			+80.0	279.2	−20.0	15		58	
Dec. 2	11	26	+54.0	240.7	−27.5		77	77	U. S. Naval.
Dec. 3	14	25	+65.0	236.9	−28.0		210	210	Mount Wilson.
Dec. 4	11	39	+79.0	239.2	−27.0		93	93	U. S. Naval.
Dec. 5	11	14		No spots					Do.
Dec. 6	11	38	+53.0	186.9	−23.0		131	131	Do.
Dec. 7	11	22	+66.0	186.9	−23.0		147	147	Do.
Dec. 8	11	58	+78.0	185.3	−23.0		108	108	Do.
Dec. 11	11	15		No spots					Do.
Dec. 12	11	11		No spots					Do.
Dec. 13	11	30		No spots					Do.
Dec. 14	11	16		No spots					Do.
Dec. 15	11	15		No spots					Do.
Dec. 16	11	15		No spots					Mount Wilson.
Dec. 17	12	0		No spots					Do.
Dec. 18	11	30		No spots					U. S. Naval.
Dec. 19	10	35		No spots					Mount Wilson.
Dec. 20	11	0	−41.0	268.7	+25.0		98		Do.
			+35.0	344.7	+18.0		4	102	
Dec. 21	11	40	−25.0	271.2	+26.0		62	62	U. S. Naval.
Dec. 22	12	6	−34.0	248.8	−23.0	31			Do.
			−15.5	267.3	+26.0	15			
			−11.0	271.8	+26.5		77	123	
Dec. 23	11	40	−50.0	219.9	−26.0		31		Do.
			−21.0	248.9	−23.0		62		
			+0.5	270.4	+26.0		62	155	
Dec. 24	10	30	−73.0	184.3	−22.0	7			Mount Wilson.
			−55.0	202.3	−29.0		4		
			−30.0	218.3	−26.0		27		
			−14.0	243.3	−27.0		4		
			−9.0	248.3	−22.0		8		
			+10.5	267.8	+25.0		84	134	
Dec. 25	11	38	−40.0	203.6	−29.0	62			U. S. Naval.
			−23.0	220.6	−25.5		46		
			+28.0	271.6	+27.0	54		162	
Dec. 26	13	59	−59.0	170.1	−23.0		93		Do.
			−28.0	201.1	−29.5		139		
			+40.5	269.6	+28.0	31		263	
Dec. 27	11	2	−47.0	170.6	−23.0		93		Do.
			−16.0	201.6	−30.0		108		
			+52.0	269.6	+28.0	16		217	
Dec. 28	13	41	−31.5	171.4	−22.5		69		Do.
			−1.5	201.4	−30.0		123		
			+66.0	268.9	+28.0	15		207	
Dec. 29	13	4	−23.0	167.1	−27.0	16			Do.
			−15.0	175.1	−22.0		46		
			+15.0	205.1	−29.5	46			
			+27.0	217.1	−28.5		23	131	
Dec. 30	13	5	+0.5	177.5	−22.0		113		Mount Wilson.
			+28.0	205.0	−30.0		56		
			+40.0	217.0	−29.0		44	213	
Dec. 31	12	50	+15.0	178.9	−22.0		22		Do.
			+21.0	184.9	−25.0		2		
			+40.0	203.9	−29.0	44			
			+54.0	217.9	−28.0		11	79	
Mean daily area for 29 days.								92	

PROVISIONAL SUN-SPOT RELATIVE NUMBERS FOR DECEMBER 1934

(Dependent alone on observations at Zurich and its station at Arosa)

[Data furnished through the courtesy of Prof. W. Brunner, Eidgen. Sternwarte, Zurich, Switzerland]

December 1934	Relative numbers	December 1934	Relative numbers	December 1934	Relative numbers
1	28	11	0	21	
2	21	12	0	22	21
3	12	13	0	23	
4	14	14	0	24	*a*27
5	*Wc*14	15		25	*Ecc*50
6	10	16	0	26	39
7	13	17	0	27	29
8	11	18	0	28	*a*34
9	0	19		29	32
10	0	20	*Ec*15	30	*a*37
				31	30

Mean: 27 days=16.2.

a=Passage of an average-sized group through the central meridian.
c=New formation of a center of activity; E, on the eastern part of the sun's disk; W, on the western part; M, in the central circle zone.

AEROLOGICAL OBSERVATIONS

[Aerological Division, D. M. LITTLE, in charge]

By L. T. SAMUELS

Free-air temperatures during December averaged lowest over the northeastern section of the country, and highest over the extreme southern stations (see table 1). Departures from normal at those stations having a sufficiently long record for the determination of normals were negative with the exception of Omaha and Pearl Harbor where positive departures occurred. In all cases the temperature departures were of small to moderate magnitude.

Free-air relative humidities averaged highest over the northwestern and northeastern parts of the country, and lowest over the extreme south, with a secondary minimum over the middle Pacific coast.

Free-air wind resultants were close to normal in direction. They were below normal in velocity over most northern stations, and above normal over the southern stations.

TABLE 1.—*Free-air temperatures and relative humidities obtained by airplanes during December 1934*

TEMPERATURE (° C.)

Stations	Altitude (meters) m. s. l.																	
	Surface		500		1,000		1,500		2,000		2,500		3,000		4,000		5,000	
	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal
Billings, Mont.[1] (1,088 m)	−3.6						−0.1		−0.9		−3.5		−7.1		−13.5		−20.1	
Boston, Mass.[2] (6 m)	−3.9		−5.3		−7.0		−9.5		−10.6		−12.2		−14.4		−19.6		−27.5	
Cheyenne, Wyo.[1] (1,873 m)	−2.9								−1.6		−0.9		−3.9		−9.4		−16.0	
Fargo, N. Dak.[1] (274 m)	−12.9		−12.6		−10.9		−7.7		−8.1		−10.1		−12.4		−17.8		−24.2	
Kelly Field (San Antonio), Tex.[3] (206 m)	8.2		11.7		11.7		10.8		9.5		7.7		5.9		−0.3		−7.3	
Lakehurst, N. J.[4] (39 m)	−2.0		−1.5		−3.7		−4.6		−6.0		−8.9		−11.1		−15.4		−22.9	
Maxwell Field (Montgomery), Ala.[3] (52 m)	4.1		6.4		6.0		6.0		5.3		4.2		2.2		−3.4		−8.2	
Mitchel Field (Hempstead, L. I.), N. Y.[3] (29 m)	−2.7		−3.5		−4.8		−5.9		−6.7		−9.0		−11.5		−16.1		−22.3	
Murfreesboro, Tenn.[1] (174 m)	0.8		1.8		0.4		0.1		−0.9		−2.8		−4.4		−8.2		−14.6	
Norfolk, Va.[4] (10 m)	3.7	−0.7	3.7	−0.3	1.9	−0.7	0.8	−0.9	−0.4	−1.1	−2.3	−1.1	−4.3	−1.1	−9.8	−1.2	−15.0	−1.2
Oklahoma City, Okla.[1] (391 m)	1.1		2.8		5.5		4.8		2.8		0.3		−2.2		−7.9		−15.3	
Omaha, Nebr.[1] (300 m)	−5.4	([6])	−5.3	([6])	−3.7	−0.8	−1.0	+1.6	−2.3	+1.7	−4.5	+1.8	−6.9	+1.8	−11.9	+2.0	−18.1	+1.3
Pearl Harbor, Territory of Hawaii [4] (6 m)	21.6	−2.7	21.2	+0.5	17.8	+0.8	14.9	+0.4	13.0	+0.6	11.3	+0.8	8.7	+0.4	3.3	+0.4	−1.7	+0.4
Pensacola, Fla.[4] (24 m)	5.0	−5.5	6.9	−3.8	6.2	−3.9	6.6	−2.4	6.2	−1.5	4.6	−1.1	2.5	−1.0	−2.1	−0.6	−7.5	−0.3
San Diego, Calif.[4] (10 m)	10.7	−2.1	13.7	+0.4	12.5	−0.1	9.7	−0.8	7.0	−1.4	4.2	−1.7	1.5	−1.9	−4.2	−1.7	−10.2	−1.6
Scott Field (Belleville), Ill.[3] (135 m)	−3.4		−1.5		−0.6		−1.2		−2.6		−4.6		−6.1		−10.5		−15.9	
Selfridge Field (Mount Clemens), Mich.[3] (177 m)	−3.9		−3.6		−4.7		−5.7		−7.2		−9.0		−10.9		−15.8		−22.2	
Spokane, Wash.[5] (596 m)	0.7				0.9		0.6		−0.5		−2.7		−5.5		−11.9		−18.7	
Sunnyvale, Calif.[4] (10 m)	8.9		9.7		8.9		7.4		5.0		3.0		0.3		−5.6		−11.7	
Washington, D. C.[4] (13 m)	1.1	−0.4	1.0	−0.7	−0.7	−1.4	−2.2	−1.7	−3.3	−1.7	−4.9	−1.2	−6.5	−1.5	−10.6	−1.3	−15.7	−1.3
Wright Field (Dayton), Ohio [3] (244 m)	−3.0		−3.1		−3.3		−4.3		−5.3		−7.0		−8.8		−13.5		−19.2	

RELATIVE HUMIDITY (PERCENT)

Stations	Surface Mean	Surface Departure	500 Mean	500 Departure	1,000 Mean	1,000 Departure	1,500 Mean	1,500 Departure	2,000 Mean	2,000 Departure	2,500 Mean	2,500 Departure	3,000 Mean	3,000 Departure	4,000 Mean	4,000 Departure	5,000 Mean	5,000 Departure
Billings, Mont.[1] (1,088 m)	60						56		52		52		54		53		50	
Boston, Mass.[2] (6 m)	70		69		69		69		64		58		56		55		41	
Cheyenne, Wyo.[1] (1,873 m)	61								59		53		52		49		44	
Fargo, N. Dak.[1] (274 m)	88		84		78		64		58		55		51		50		48	
Kelly Field (San Antonio), Tex.[3] (206 m)	87		71		57		47		40		40		36		33		25	
Lakehurst, N. J.[4] (39 m)	84		78		75		70		65		64		62		57		55	
Maxwell Field (Montgomery), Ala.[3] (52 m)	83		67		59		46		40		38		36		34		31	
Mitchel Field (Hempstead, L. I.), N. Y.[3] (29 m)	75		66		62		56		51		51		50		45		47	
Murfreesboro, Tenn.[1] (174 m)	80		72		70		56		50		48		41		36		35	
Norfolk, Va.[4] (10 m)	70	−1	61	−1	56	−2	51	0	45	+1	43	0	43	+1	40	0	33	0
Oklahoma City, Okla.[1] (391 m)	80		74		61		53		47		43		40		37		35	
Omaha, Nebr.[1] (300 m)	87	([6])	84	([6])	75	+12	61	+4	57	+2	54	−2	52	−5	51	−6	49	−8
Pearl Harbor, Territory of Hawaii [4] (6 m)	84	+11	80	+4	80	+3	76	+5	68	+5	60	+6	54	+8	48	+8	43	+8
Pensacola, Fla.[4] (24 m)	72	−10	61	−13	54	−12	43	−16	34	−19	32	−19	31	−18	27	−13	25	−13
San Diego, Calif.[4] (10 m)	82	+15	66	+8	57	+9	54	+12	53	+17	47	+15	44	+15	43	+16	40	+17
Scott Field (Belleville), Ill.[3] (135 m)	82		69		60		49		47		44		40		40		39	
Selfridge Field (Mount Clemens), Mich.[3] (177 m)	84		77		72		63		51		44		42		38		38	
Spokane, Wash.[5] (596 m)	85				83		74		65		63		61		54		56	
Sunnyvale, Calif.[4] (10 m)	70		61		52		44		43		37		36		35		37	
Washington, D. C.[4] (13 m)	69	−3	62	−2	59	0	55	0	48	−2	41	−5	30	−4	37	−5	35	−5
Wright Field (Dayton), Ohio [3] (244 m)	81		79		70		60		51		45		45		43		44	

Observations taken about 5 a. m., 75th meridian time, except along the Pacific coast and Hawaii where they are taken at daylight.

[1] Weather Bureau. [2] Massachusetts Institute of Technology. [3] Army. [4] Navy. [5] National Guard.
[6] Surface and 500-meter level departures omitted because of difference in time of day between airplane observations and those of kites upon which the normals are based.

LATE REPORTS FOR NOVEMBER 1934

TEMPERATURE (° C.)

Stations	Altitude (meters) m. s. l.																	
	Surface		500		1,000		1,500		2,000		2,500		3,000		4,000		5,000	
	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal
Pearl Harbor, Territory of Hawaii (6 m)	22.5	−3.2	21.9	+0.2	18.6	+0.8	15.3	+0.2	13.9	+0.8	12.2	+1.0	9.8	+0.8	4.0	+0.7	−0.6	+0.7

RELATIVE HUMIDITY (PERCENT)

Stations	Surface		500		1,000		1,500		2,000		2,500		3,000		4,000		5,000	
Pearl Harbor, Territory of Hawaii (6 m)	84	+15	81	+7	82	+4	82	+9	73	+8	64	+9	58	+12	50	+12	47	+12

TABLE 2.—*Free-air resultant winds (meters per second) based on pilot-balloon observations made near 7 a. m. (E. S. T.) during December 1934*

[Wind from N=360°, E=90°, etc.]

Altitude (m) m. s. l.	Albuquerque, N. Mex. (1,554 m)		Atlanta, Ga. (309 m)		Bismarck, N. Dak. (518 m)		Brownsville, Tex. (7 m)		Burlington, Vt. (132 m)		Cheyenne, Wyo. (1,873 m)		Chicago, Ill. (192 m)		Cleveland, Ohio (245 m)		Dallas, Tex. (154 m)		Havre, Mont. (762 m)		Jacksonville, Fla. (14 m)		Key West, Fla. (11 m)	
	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity
	°		°		°		°		°		°		°		°		°		°		°		°	
Surface	355	1.7	314	1.8	313	1.1	321	0.2	223	0.8	281	5.3	277	2.5	234	1.8	14	0.1	253	3.0	321	1.4	39	2.6
500			314	3.5			156	3.8	249	3.8			284	3.7	235	4.6	256	4.4			308	2.8	82	3.7
1,000			285	6.0	295	7.5	161	3.0	285	8.0			287	4.6	246	6.4	286	6.6	262	5.6	260	5.1	116	3.2
1,500			293	8.0	296	8.6	211	2.9	296	10.5			281	5.9	250	8.1	300	7.7	281	10.0	267	7.0	113	1.3
2,000	320	2.3	285	10.3	294	12.4	230	3.7	301	10.0	282	7.6	270	5.2	255	8.8	302	9.1	288	9.3	271	9.6	213	0.6
2,500	294	4.3	274	12.7	300	11.8	264	4.4	300	12.3	285	13.7	292	9.3	271	10.0	294	10.9	294	10.5	277	11.0	250	1.7
3,000	287	7.3	262	13.4	293	13.2	283	5.8	293	12.0	288	13.0	312	9.6	279	7.6	288	13.0	291	11.8	273	12.5	227	2.3
4,000	287	9.9					278	8.2			300	12.9			280	10.2	280	13.5	296	11.3			182	3.8
5,000	266	7.6					276	9.1																

Altitude (m) m. s. l.	Los Angeles, Calif. (217 m)		Medford, Oreg. (410 m)		Memphis, Tenn. (83 m)		New Orleans, La. (19 m)		Oakland, Calif. (8 m)		Oklahoma City, Okla. (402 m)		Omaha, Nebr. (306 m)		Phoenix, Ariz. (338 m)		Salt Lake City, Utah (1,294 m)		Sault Ste. Marie, Mich. (198 m)		Seattle, Wash. (14 m)		Washington, D. C. (10 m)	
	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity
	°		°		°		°		°		°		°		°		°		°		°		°	
Surface	6	1.4	183	0.5	271	0.3	14	2.1	68	0.9	283	0.7	343	1.8	87	1.6	173	1.6	56	1.3	196	3.2	305	1.6
500	39	1.5	246	0.2	264	3.4	331	1.1	23	4.7	286	2.2	312	2.4	77	3.2			6	1.2	208	6.7	305	5.7
1,000	59	2.2	170	2.8	264	6.3	290	4.0	10	5.4	296	6.2	298	5.5	88	2.5			301	3.2	220	6.1	311	6.8
1,500	59	2.1	205	3.3	284	7.4	283	5.5	354	4.1	290	7.4	288	6.4	122	2.6	188	2.7	316	4.9	232	7.0	309	9.5
2,000	41	1.2	229	2.9	287	9.0	281	7.3	357	5.6	286	9.4	282	8.8	197	0.8	205	2.3	309	6.6	242	9.3	304	11.3
2,500	4	2.8	253	3.4	286	11.9	279	8.3	359	7.3	286	10.3	285	10.2	213	1.5	241	3.3	316	6.6	231	8.7	303	12.5
3,000	345	4.7	275	3.9	275	13.7	272	10.8	341	6.5	278	11.3	278	7.9	270	2.5	255	5.3	348	8.0	243	10.5		
4,000	330	5.7	244	5.7					286	3.8	266	14.2			263	4.2	297	4.5	335	13.6				
5,000															250	5.9								

AEROLOGICAL OBSERVATIONS FOR THE YEAR 1934

[Aerological Division, D. M. LITTLE in charge]

By L. T. SAMUELS

In July the number of airplane weather observation stations was materially increased in consequence of the cooperative program of the Navy and War Departments and the Weather Bureau. A total of 24 such stations, including 1 at Boston operated by the Massachusetts Institute of Technology and 1 at Toronto operated by the Canadian Meteorological Service, were making observations at the end of 1934. The total number of pilot-balloon stations in operation by the Weather Bureau at the end of 1934 was 76, an increase of 2 over the previous year.

Only those stations having a year's record are included in table 1. Free-air temperatures averaged mostly above normal except at the stations along the Gulf and eastern seaboard, where negative departures occurred. Free-air relative humidities averaged above normal except at Omaha and Seattle, where they averaged below normal.

During the International month of January, the Weather Bureau released 46 sounding balloons at Omaha, Nebr. Ninety-six percent, i. e., 44, of the meteorographs were found and returned.

TABLE 1.—*Free-air temperatures and relative humidities obtained by airplanes during the year 1934*

TEMPERATURE (°C.)

Stations	Altitude (meters) m. s. l.: Surface, Mean	Surface, Departure from normal	500, Mean	500, Departure from normal	1,000, Mean	1,000, Departure from normal	1,500, Mean	1,500, Departure from normal	2,000, Mean	2,000, Departure from normal	2,500, Mean	2,500, Departure from normal	3,000, Mean	3,000, Departure from normal	4,000, Mean	4,000, Departure from normal	5,000, Mean	5,000, Departure from normal
Norfolk, Va.[1] (10 m.)	13.3	−0.9	12.8	−0.6	11.0	−0.4	8.9	−0.3	6.7	−0.1	4.5	0.0	2.2	+0.1				
Omaha, Nebr.[2] (300 m)	7.9	([3])	9.4	([3])	10.8	+2.8	9.7	+3.1	7.6	+3.2	4.8	+3.0	1.8	+2.8	−4.6	+2.2	−11.3	+1.5
Pearl Harbor, Territory of Hawaii[1] (6 m)	23.8	−2.1	21.3	−0.4	17.6	−0.1	14.9	−0.2	12.8	+0.1	10.9	−0.1	8.9	−0.3				
Pensacola, Fla.[1] (24 m)	16.5	−1.5	15.8	−1.3	13.9	−1.2	11.8	−1.2	9.6	−1.0	7.0	−1.1	4.3	−1.2	−1.5	−1.2	−7.5	−1.1
San Diego, Calif.[1] (10 m)	16.1	−1.0	15.6	+0.1	16.4	+0.5	15.2	+0.8	13.4	+0.7	10.6	+0.5	7.8	+0.4	1.2			
Seattle, Wash.[1] (8 m)	14.0	+0.6	11.4	+0.9	9.3	+1.1	7.0	+1.1	4.6	+1.1	2.0	+1.0	−0.9	+0.6	−7.2			
Sunnyvale, Calif.[1] (10 m)	13.7		12.4		13.2		12.5		10.5		7.4		4.2		−3.1			
Washington, D. C.[1] (12 m)	9.9	−2.1	10.0	−0.9	8.5	−0.7	6.6	−0.7	4.8	−0.3	2.8	−0.2	0.6	−0.2				

RELATIVE HUMIDITY (PERCENT)

Stations	Surface, Mean	Surface, Departure from normal	500, Mean	500, Departure from normal	1,000, Mean	1,000, Departure from normal	1,500, Mean	1,500, Departure from normal	2,000, Mean	2,000, Departure from normal	2,500, Mean	2,500, Departure from normal	3,000, Mean	3,000, Departure from normal	4,000, Mean	4,000, Departure from normal	5,000, Mean	5,000, Departure from normal
Norfolk, Va.[1] (10 m)	78	+5	70	+5	66	+5	63	+5	60	+5	57	+5	53	+5				
Omaha, Nebr.[2] (300 m)	76	([3])	70	([3])	59	−2	54	−3	51	−4	50	−5	50	−5	50	−3	48	−4
Pearl Harbor, Territory of Hawaii[1] (6 m)	77	+11	78	+6	81	+3	76	+4	65	0	53	+1	43	+3				
Pensacola, Fla.[1] (24 m)	81	0	74	0	70	+2	66	+3	61	+2	58	+3	56	+5	51	+5	47	+4
San Diego, Calif.[1] (10 m)	78	+8	73	+4	55	+3	45	+2	38	+3	36	+4	35	+6	34			
Seattle, Wash.[1] (8 m)	69	−2	70	−2	67	−3	64	−2	61	−1	58	0	54	+1	48			
Sunnyvale, Calif.[1] (12 m)	77		74		59		47		41		37		35		31			
Washington, D. C.[1] (13 m)	74	+3	66	+2	63	+3	61	+3	58	+2	54	+2	51	+3				

Observations taken about 5 a. m., 75th meridian time, except along the Pacific coast and Hawaii where they are taken at daylight.

[1] Navy.

[2] Weather Bureau,

[3] Surface and 500-meter level departures omitted because of difference in time of day between airplane observations and those of kites upon which the normals are based.

RIVERS AND FLOODS

[River and Flood Division, MONTROSE W. HAYES, in charge]

By RICHMOND T. ZOCH

Heavy rains during the last few days of November, continuing in a few places into December, caused some rather high floods in many of the rivers in Virginia and North Carolina.

The Shenandoah had the highest flood since 1924. At Columbia, the James experienced its greatest flood since 1877, although at Richmond it was the highest only since 1924. Damage in the river valleys in North Carolina was considerable, but it was not extensive in the Shenandoah and James Valleys.

The remaining floods shown in the table of flood stages in December were of minor consequence.

The other tables are statements of estimated flood losses, and savings effected by Weather Bureau flood warnings, during 1934.

Table of Flood Stages in December 1934

[All dates are in December unless otherwise specified]

River and station	Flood stage	Above flood stages—dates: From—	To—	Crest: Stage	Date
ATLANTIC SLOPE DRAINAGE	*Feet*			*Feet*	
Lackawaxen: Hawley, Pa	6	1	2	6.6	1
Schuylkill: Reading, Pa	7	1	2	11.2	1
Shenandoah: Riverton, Va	22	2	2	23.7	2
Potomac: Sycamore Island, Md	10	2	3	12.7	3
James:					
Buchanan, Va	17	1	1	17.0	1
Lynchburg, Va	18	1	1	19.6	1
Columbia, Va	18	Nov. 30	4	31.7	2
Richmond, Va	8	Nov. 30	4	19.7	3
Dan:					
Danville, Va	10	1	1	11.3	1
Clarksville, Va	12	2	3	13.6	3
Roanoke:					
Randolph, Va	21	1	3	27.0	2
Weldon, N. C	31	Nov. 30	6	43.3	4
Williamston, N. C	10	5	14	13.9	8
Fishing Creek: Enfield, N. C	15	1	3	17.5	2
Tar:					
Rocky Mount, N. C	10	1	5	13.7	3
Tarboro, N. C	18	4	8	26.3	6
Greenville, N. C	14	5	11	18.8	8

Table of Flood Stages in December 1934—Continued

[All dates are in December unless otherwise specified]

River and station	Flood stage	Above flood stages—dates: From—	To—	Crest: Stage	Date
ATLANTIC SLOPE DRAINAGE—continued					
Neuse:	*Feet*			*Feet*	
Neuse, N. C	15	Nov. 29	6	21.4	Nov. 30
Smithfield, N. C	14	Nov. 30	7	22.5	2
Haw: Moncure, N. C	22	1	1	22.0	1
Cape Fear:					
Fayetteville, N. C	35	2	3	39.0	3
Lock No. 2, Elizabethtown, N. C	22	1	5	29.3	4
Peedee:					
Cheraw, S. C	27	2	3	32.2	3
Mars Bluff Bridge, S. C	17	3	9	18.5	8
Poston, S. C	18	10	11	18.0	10, 11
Santee:					
		1	9	14.6	3
Rimini, S. C	12	13	14	12.4	14
		20	22	12.6	21
Ferguson, S. C	12	6	6	12.0	6
Savannah: Ellentown, S. C	14	4	4	14.0	4
EAST GULF OF MEXICO DRAINAGE					
Tombigbee: Lock No. 3, Ala	33	29	([1])	39.2	30
Pearl:					
Jackson, Miss	18	Nov. 29	2	18.5	1
		27	([1])	24.0	31
Monticello, Miss	15	29	31	17.3	30
West Pearl: Pearl River, La	12	1	7	12.2	5
MISSISSIPPI SYSTEM					
Lower Mississippi Basin					
Big Lake Outlet: Manila, Ark	10	Nov. 26	17	13.5	3, 4
Tallahatchie: Swan Lake, Miss	26	5	18	27.3	10
WEST GULF OF MEXICO DRAINAGE					
Guadalupe: Victoria, Tex	21	30	31	23.6	31
PACIFIC SLOPE DRAINAGE					
Columbia Basin					
Coast Fork: Saginaw, Oreg	9	20	20	9.9	20
Long Tom: Monroe, Oreg	10	29	31	13.9	31
Santiam: Jefferson, Oreg	10	20	20	12.5	20
Willamette:					
Harrisburg, Oreg	10	21	23	13.0	21
Oregon City, Oreg	12	25	25	12.0	25

[1] Flood continued into January, 1935.

STATEMENT OF ESTIMATED FLOOD LOSSES DURING THE YEAR 1934

ATLANTIC SLOPE DRAINAGE

Connecticut River in Connecticut	
Tangible property totally or partially destroyed	$11, 200
Prospective crops	1, 250
Livestock and other movable property	300
Suspension of business, including wages of employees	4, 000
Hudson River in New York	
Tangible property totally or partially destroyed	800
Chenango River in New York	
Tangible property totally or partially destroyed	15, 400
Prospective crops	4, 000
Susquehanna River in New York and Pennsylvania	
Tangible property totally or partially destroyed	70, 900
Matured crops	2, 000
Prospective crops	2, 800
Livestock and other movable property	330
Suspension of business, including wages of employees	1, 350
James River in Virginia	
Tangible property totally or partially destroyed	30, 000
Roanoke River in Virginia and North Carolina	
Tangible property totally or partially destroyed	3, 000
Prospective crops	9, 000
Matured crops	4, 800
Livestock and other movable property	200
Suspension of business, including wages of employees	17, 500
Tar River in North Carolina	
Tangible property totally or partially destroyed	60, 000
Suspension of business, including wages of employees	10, 000
Neuse River in North Carolina	
Tangible property totally or partially destroyed	55, 000
Suspension of business, including wages of employees	9, 000
Cape Fear River in North Carolina	
Tangible property totally or partially destroyed	11, 000
Suspension of business, including wages of employees	3, 500
Saluda River in South Carolina	
Tangible property totally or partially destroyed	400
Matured crops	700
Broad River in South Carolina	
Prospective crops	500
Matured crops	1, 000
Suspension of business, including wages of employees	100
Congaree River in South Carolina	
Matured crops	500
Livestock and other movable property	50
Suspension of business, including wages of employees	1, 000
Santee River in South Carolina	
Tangible property totally or partially destroyed	300
Prospective crops	11, 000
Matured crops	10, 000
Suspension of business, including wages of employees	20, 200
Savannah River in Georgia and South Carolina	
Livestock and other movable property	250
Suspension of business, including wages of employees	1, 400
Ocmulgee River in Georgia	
Tangible property totally or partially destroyed	800
Suspension of business, including wages of employees	600
Total	376, 130

STATEMENT OF ESTIMATED FLOOD LOSSES DURING THE YEAR 1934—Continued

EAST GULF OF MEXICO DRAINAGE

Apalachicola River in Florida	
Tangible property totally or partially destroyed	$200
Livestock and other movable property	600
Suspension of business, including wages of employees	1, 000
Black Warrior River in Alabama	
Tangible property totally or partially destroyed	1, 000
Matured crops	4, 500
Livestock and other movable property	300
Suspension of business, including wages of employees	100
Tombigbee River in Alabama and Mississippi	
Tangible property totally or partially destroyed	1, 375
Livestock and other movable property	250
Suspension of business, including wages of employees	150
Pascagoula River in Mississippi	
Tangible property totally or partially destroyed	500
Prospective crops	100
Matured crops	100
Livestock and other movable property	200
Suspension of business, including wages of employees	2, 200
Pearl River in Mississippi	
Matured crops	300
Livestock and other movable property	250
Suspension of business, including wages of employees	1, 580
Total	14, 705

MISSISSIPPI SYSTEM—UPPER MISSISSIPPI BASIN

Small streams in Minnesota and Wisconsin	
Tangible property totally or partially destroyed	1, 236, 000
Wisconsin River in Wisconsin	
Prospective crops	3, 600
Matured crops	750
Bourbeuse River in Missouri	
Matured crops	7, 500
Total	1, 247, 850

MISSISSIPPI SYSTEM—MISSOURI BASIN

Big Sioux River in Iowa and South Dakota	
Tangible property totally or partially destroyed	70, 000
Prospective crops	25, 000
Perry Creek in Iowa	
Tangible property totally or partially destroyed	130, 000
Prospective crops	4, 000
Matured crops	1, 000
Livestock and other movable property	1, 000
Suspension of business, including wages of employees	1, 000
Floyd River in Iowa	
Tangible property totally or partially destroyed	278, 000
Prospective crops	10, 000
Livestock and other movable property	15, 000
Suspension of business, including wages of employees	32, 000
Solomon River in Kansas	
Tangible property totally or partially destroyed	1, 300
Prospective crops	1, 500
Matured crops	1, 000
Livestock and other movable property	1, 200
Grand River in Missouri	
Tangible property totally or partially destroyed	110, 000
Matured crops	521, 370
Livestock and other movable property	50, 000
Suspension of business, including wages of employees	575, 000

STATEMENT OF ESTIMATED FLOOD LOSSES DURING THE YEAR 1934—Continued

MISSISSIPPI SYSTEM—MISSOURI BASIN—continued

Missouri River in Kansas and Missouri

Tangible property totally or partially destroyed	$18, 942
Matured crops	4, 692
Livestock and other movable property	4, 955
Total	1, 856, 959

MISSISSIPPI SYSTEM—OHIO BASIN

Allegheny River in Pennsylvania

Tangible property totally or partially destroyed	92, 600
Suspension of business, including wages of employees	3, 000

Monongahela River in Pennsylvania

Tangible property totally or partially destroyed	61, 267
Suspension of business, including wages of employees	4, 000

Kentucky River in Kentucky

Tangible property totally or partially destroyed	1, 000

Barren River in Kentucky

Tangible property totally or partially destroyed	500
Prospective crops	1, 000
Matured crops	500
Suspension of business, including wages of employees	400

Green River in Kentucky

Tangible property totally or partially destroyed	300
Suspension of business, including wages of employees	1, 000

Cumberland River in Tennessee

Tangible property totally or partially destroyed	151, 975
Prospective crops	150, 000
Livestock and other movable property	2, 000
Suspension of business, including wages of employees	6, 250

Nolichucky River in Tennessee

Tangible property totally or partially destroyed	93, 000
Prospective crops	71, 400
Matured crops	12, 500
Suspension of business, including wages of employees	1, 000

Elk River in Tennessee

Tangible property totally or partially destroyed	7, 050
Prospective crops	3, 500
Suspension of business, including wages of employees	600

Duck River in Tennessee

Livestock and other movable property	50

Tennessee River in Tennessee

Tangible property totally or partially destroyed	150
Prospective crops	500
Livestock and other movable property	10, 200
Suspension of business, including wages of employees	5, 300

Ohio River in Kentucky

Tangible property totally or partially destroyed	900
Livestock and other movable property	100
Suspension of business, including wages of employees	250
Total	682, 292

MISSISSIPPI SYSTEM—WHITE BASIN

White River in Arkansas

Tangible property totally or partially destroyed	1, 500
Prospective crops	5, 000
Matured crops	600
Livestock and other movable property	1, 250
Suspension of business, including wages of employees	1, 000
Total	9, 350

STATEMENT OF ESTIMATED FLOOD LOSSES DURING THE YEAR 1934—Continued

MISSISSIPPI SYSTEM—ARKANSAS BASIN

Purgatoire River in Colorado

Tangible property totally or partially destroyed	$800

MISSISSIPPI SYSTEM—RED BASIN

Ouachita River in Arkansas

Tangible property totally or partially destroyed	9, 500
Prospective crops	10, 000
Matured crops	200
Livestock and other movable property	5, 400
Suspension of business, including wages of employees	3, 000

Sulphur River in Texas

Tangible property totally or partially destroyed	100
Prospective crops	10, 100
Livestock and other movable property	105
Suspension of business, including wages of employees	2, 500

Small Streams in Oklahoma

Tangible property totally or partially destroyed	507, 100
Prospective crops	40, 500
Livestock and other movable property	40, 000
Total	628, 505

MISSISSIPPI SYSTEM—LOWER MISSISSIPPI BASIN

Tallahatchie River in Mississippi

Suspension of business, including wages of employees	100

WEST GULF OF MEXICO DRAINAGE

Sabine River in Texas

Tangible property totally or partially destroyed	91, 600
Prospective crops	25, 000
Matured crops	225, 000
Livestock and other movable property	20, 000
Suspension of business, including wages of employees	50, 000

Trinity River in Texas

Prospective crops	7, 800
Livestock and other movable property	3, 000
Suspension of business, including wages of employees	700
Total	423, 100

GULF OF CALIFORNIA DRAINAGE

Small Streams in Arizona and Colorado

Tangible property totally or partially destroyed	111, 500

PACIFIC SLOPE DRAINAGE

Small Streams in California

Tangible property totally or partially destroyed	5, 000, 000
Total estimated losses for the United States	10, 351, 291

ESTIMATED VALUE OF PROPERTY SAVED BY WARNINGS

ATLANTIC SLOPE DRAINAGE

Hudson River in New York	$2, 000
Susquehanna River in New York	500
James River in Virginia	10, 000
Roanoke River in Virginia and North Carolina	159, 700
Tar River in North Carolina	36, 000
Neuse River in North Carolina	39, 000
Cape Fear River in North Carolina	30, 000
Peedee River in South Carolina	5, 000
Saluda River in South Carolina	2, 000
Broad River in South Carolina	2, 000
Congaree River in South Carolina	3, 000
Santee River in South Carolina	13, 000
Savannah River in Georgia and South Carolina	33, 900
Ocmulgee River in Georgia	3, 500

ESTIMATED VALUE OF PROPERTY SAVED BY WARNINGS—Continued

EAST GULF OF MEXICO DRAINAGE	
Apalachicola River in Florida	$4,000
Etowah River in Georgia	1,000
Black Warrior River in Alabama	7,500
Tombigbee River in Mississippi and Alabama	25,250
Pascagoula River in Mississippi	21,200
Pearl River in Mississippi	2,075
MISSISSIPPI SYSTEM—UPPER MISSISSIPPI BASIN	
Wisconsin River in Wisconsin	2,850
MISSISSIPPI SYSTEM—MISSOURI BASIN	
Big Sioux River in Iowa	36,800
Floyd River in Iowa	210,000
Grand River in Missouri	800,000
MISSISSIPPI SYSTEM—OHIO BASIN	
Allegheny River in Pennsylvania	50,000
Monongahela River in Pennsylvania	200,000
Barren River in Kentucky	10,000
Green River in Kentucky	10,000
MISSISSIPPI SYSTEM—OHIO BASIN—continued	
Cumberland River in Tennessee	$21,100
Elk River in Tennessee	2,000
Duck River in Tennessee	2,000
Tennessee River in Tennessee	20,000
Ohio River in Indiana and Kentucky	80,156
MISSISSIPPI SYSTEM—WHITE BASIN	
White River in Arkansas	11,300
MISSISSIPPI SYSTEM—ARKANSAS BASIN	
Petit Jean River in Arkansas	500
MISSISSIPPI SYSTEM—RED BASIN	
Ouachita River in Arkansas	22,500
Sulphur River in Texas	55,500
WEST GULF OF MEXICO DRAINAGE	
Sabine River in Texas	12,000
Trinity River in Texas	15,000
Total estimated savings for the United States	1,962,331

WEATHER OF THE ATLANTIC AND PACIFIC OCEANS

[The Marine Division, W. F. McDONALD in charge]

NORTH ATLANTIC OCEAN, DECEMBER 1934

By H. C. HUNTER

Atmospheric pressure.—The abnormally low pressure in the general region of the Azores, which prevailed during the final week of November, continued to be a feature of North Atlantic weather during a great part of December 1934, although there and in other southeastern portions of the ocean area the barometer was comparatively high from the 15th to 21st, and again during the final 5 days. Over higher northern latitudes low pressure prevailed throughout the month, particularly near Ireland, where the December average pressure at Valencia was 29.35 inches, more than half an inch below normal, and readings were at all times below 30 inches.

The West Indies and Gulf regions averaged a little above normal pressure. At Bermuda the opening week of December was marked by rather high barometer, but the second week by low.

The highest reading so far reported by a vessel was 30.53 inches on the 20th, by the British steamship *Camito*, about latitude 40° north, longitude 48° west. The lowest pressure was 27.81 inches, encountered by the American steamship *Minnequa*, late on the 24th, near 56° north, 27° west. At about the same longitude, but near 50° latitude, several steamers noted readings almost as low when within an intense storm area during the night of the 13th–14th.

TABLE 1.—*Averages, departures, and extremes of atmospheric pressure (sea level) at selected stations for the North Atlantic Ocean and its shores, December 1934*

Station	Average pressure	Departure	Highest	Date	Lowest	Date
	Inches	*Inch*	*Inches*		*Inches*	
Julianehaab, Greenland	29.33	----------	29.91	1	28.85	26
Reykjavik, Iceland	29.41	−0.06	29.98	4	28.57	11
Lerwick, Shetland Islands	29.55	−.17	30.24	25	29.10	15
Valencia, Ireland	29.35	−.59	29.92	1, 31	28.48	15
Lisbon, Portugal	30.10	−.01	30.52	31	29.78	9
Madeira	30.16	+.07	30.32	30, 31	30.01	12
Horta, Azores	29.90	−.24	30.31	19	29.45	24
Belle Isle, Newfoundland	29.48	−.22	30.18	4	28.64	21
Halifax, Nova Scotia	29.87	−.08	30.34	19	29.04	20
Nantucket	30.00	−.05	30.48	3	29.16	20
Hatteras	30.11	−.02	30.48	27	29.52	19
Bermuda	30.07	−.05	30.38	24	29.60	11, 12
Turks Island	30.06	+.03	30.13	3, 16	29.91	11
Key West	30.10	+.02	30.32	12	29.91	11
New Orleans	30.19	+.06	30.49	11	29.85	18

NOTE.—All data based on a. m. observations only, with departures compiled from best available normals related to time of observation, except Hatteras, Key West, Nantucket, and New Orleans which are 24-hour corrected means.

Cyclones and gales.—Seldom has the North Atlantic Ocean known so stormy a month as December 1934. The number of gale reports in hand at this writing is 283, of which 15 state the highest wind force as 12, and 35 as 11; it is not feasible to present all of the latter group of reports in the accompanying table.

East of Newfoundland the storm centers were usually located north of the chief steamship lanes, so that the strong winds were nearly all from a westerly direction. A characteristic report was that of the American steamship *West Kyska*, bound from Bremen to Panama City, Fla., which left the English Channel late on the 14th, and thereafter, till near 41° N., 25° W., late on the 21st had wind always from a westerly point and at no time of force less than 6.

For the first few days of December the storm activity was not unusually great for the time of the year. But by the 4th a vigorous LOW was central near Nova Scotia, from whence it advanced to east-northeast and later northeast, till on the 10th it was south of Iceland. Chart VIII, for the 8th, shows this storm affecting a large area near and to eastward of midocean; such fully developed storminess was typical of the period from the 5th to the 20th. A lesser disturbance also is indicated on chart VIII near Cape Hatteras; it had already gained considerable intensity in its progress northward from the region of the Bahamas during the preceding 2 days, and continued to intensify with further progress northeastward.

Chart IX, for December 11, shows this storm center near midocean and of great intensity. Gales were prevailing on the 11th and 12th from the Bahamas to the Irish coast. Another LOW was again developing near the American coast, somewhat to eastward of Delaware Bay, traveling northeastward, and behind it the eastern part of the United States was experiencing a marked cold wave.

The storm just mentioned as near Delaware Bay was of great energy by the 13th, centered not far from the Grand Banks, and the situation of that date is shown on chart X. In this storm near 50° N., 35° W., the British steamship *Usworth*, from Montreal for Great Britain, was in distress, and on December 14th she was abandoned; 15 of her crew and 2 officers engaged in the work of rescue

from the Belgian steamship *Jean Jadot*, lost their lives by a boat capsizing. The other 11 men of the *Usworth* were rescued by the *Jean Jadot* and the British steamship *Ascania*.

On the 15th another energetic LOW was near Newfoundland, and advanced eastward till the situation of the 18th appearing on chart XI, had developed. That day the Norwegian steamship *Sisto* was abandoned, about 500 miles west of Ireland, the German liner *New York* rescuing all hands.

From the 20th onward, the storms traversing the North Atlantic, though important, were usually less intense, especially near the route from northern United States ports to the English Channel. The chief LOW of this period was, however, well developed on the 24th and 25th, when central about midway between northern Newfoundland and northern Ireland.

While only two major casualties due to stress of weather in December have come to notice, as reported above, the widespread and severe storminess caused much minor damage to shipping, in boats and gear lost or smashed, and in strained plates and damage to superstructures.

Fog.—Scarcely any fog was reported during December from the Grand Banks region. Over the eastern part of the ocean, however, there was somewhat more than during November, chiefly near the fiftieth parallel, between 30° W. and the British and French coasts, the first 4 days of the month being the notable time of occurrence.

In the vicinity of the American coast, from Nova Scotia to South Carolina, some fog occurred on various dates, the principal period being about the 11th to southward of the fortieth parallel. The square from 35° to 40° N., 70° to 75° W., furnished reports of fog on 6 different days altogether. In the northwestern part of the Gulf of Mexico some fog was encountered about the 18th, and again during the final 5 days of December.

OCEAN GALES AND STORMS, DECEMBER 1934

Vessel	Voyage: From—	Voyage: To—	Position at time of lowest barometer: Latitude	Position at time of lowest barometer: Longitude	Gale began December—	Time of lowest barometer December—	Gale ended December—	Lowest barometer	Direction of wind when gale began	Direction and force of wind at time of lowest barometer	Direction of wind when gale ended	Direction and highest force of wind	Shifts of wind near time of lowest barometer
NORTH ATLANTIC OCEAN			° ′	° ′				Inches					
Silverteak, Br. M. S.	Gibraltar	Halifax	[1] 38 02 N.	32 51 W.	2	3p, 2	2	29.54	SW	SW, 10	WNW	SW, 10	WNW-SW-WNW.
City of Joliet, Am. S. S.	Malmo	Tampico	36 55 N.	28 13 W.	2	9p, 2	3	29.56	SW	SW, 10	WNW	SW, 10	SW-W.
Nishmaha, Am. S. S.	Hamburg	New Orleans	39 45 N.	25 48 W.	3	2a, 3	5	29.43	WSW	SSW, 7	WNW	WNW, 9	S-W.
Lucia C., Ital. S. S.	Galveston	Algiers	38 22 N.	20 43 W.	5	2a, 5	5	29.60	SSW	SSW, 10	SSW	SSW, 10	None.
Rotterdam, Du. M. S.	Rotterdam	Baton Rouge	41 56 N.	24 41 W.	4	4a, 5	8	29.30	SW	WSW, 9	WSW	WSW, 9	
Bennekom, Du. S. S.	Curacao	Liverpool	43 10 N.	23 40 W.	3	11a, 5	5	[2] 29.19	WNW	WSW, 9	NW	WSW, 9	None.
Svanhild, Dan. S. S.	Bremen	Norfolk	45 57 N.	54 18 W.	5	do	6	28.82	S	SW, 10	NW	SW, 11	S-SW-WNW.
Blankaholm, Swed. M. S.	Gothenburg	New York	45 35 N.	56 35 W.	5	1p, 5	6	28.98	SW	W, 10	NW	NNW, 11	SW-W-NNW.
Boston City, Br. S. S.	Fowey	Portland, Maine	46 16 N.	43 40 W.	5	4p, 6	8	28.65	S	W, 10	W	W, 11	WSW-W.
Lord Kelvin, Br. S. S.	London	Halifax	46 28 N.	38 18 W.	6	10p, 6	8	28.68	S	W, 8	WNW	W, 11	Steady.
City of Baltimore, Am. S. S.	Havre	Norfolk	47 22 N.	33 45 W.	7	Noon, 7	8	28.62	WSW	WSW, 7	WSW	WSW, 11	None.
Nerissa, Br. S. S.	New York	St. Thomas	33 00 N.	70 37 W.	8	2a, 8	8	29.31	S	SW, 9	NW	WSW, 9	S-SW-NW.
Indiana, Fr. S. S.	Antwerp	Guadeloupe	40 05 N.	22 15 W.	7	5a, 8	9	29.37	SSW	WSW, 11	WSW	W, 12	W-SW.
Cheyenne, Br. M. S.	Philadelphia	London	43 15 N.	42 37 W.	6	9a, 8	8	29.58	WNW	WNW, 11	WNW	WNW, 11	None.
J. A. Moffett, Jr., Am. M. S.	Havre	Aruba	42 25 N.	23 38 W.	7	1p, 8	9	29.20	WNW	W, 10	WNW	W, 12	WSW-WNW.
Birmingham City, Am. S. S.	Bristol	Baltimore	38 15 N.	59 40 W.	8	3p, 8	8	29.15	ESE	SW, 9	WNW	SW, 10	S-SW-W.
Ajax, Du. S. S.	Amsterdam	San Juan	41 23 N.	14 38 W.	8	10p, 8	9	29.37	SW	SW, 11	WSW	SW, 12	SW-NW.
Sagaporack, Am. S. S.	Copenhagen	New York	44 00 N.	51 00 W.	9	1a, 9	9	29.02	W	S, 6	W	SW, 12	SE-S-W.
Paris, Fr. S. S.	Havre	do	47 01 N.	45 36 W.	9	1p, 9	9	29.02	SW	WSW, 10	WSW	WSW, 10	SE-WSW.
Brasilien, Dan. S. S.	Buenos Aires	Copenhagen	[1] 48 51 N.	4 50 W.	9	5a, 10	10	28.99	SW	SSW, 11	WSW	SSW, 12	SSW-WSW.
Bremen, Ger. S. S.	Cherbourg	New York	49 00 N.	27 24 W.	10	1p, 10	11	29.11	W	W, 11	W	W, 11	None.
West Camak, Am. S. S.	New Orleans	Huelva	35 08 N.	61 09 W.	11	3a, 12	12	29.35	SW	S, 7	SW	SW, 9	SW-S-SW.
New Brunswick, Br. S. S.	Freetown	Boston	33 21 N.	54 16 W.	12	6p, 12	13	29.72	S	SSW, 10	W	SSW, 10	S-SSW-W.
Kentucky, Dan. S. S.	Norfolk	Rotterdam	46 50 N.	34 40 W.	13	9p, 13	14	28.66	SW	W, 12	WNW	W, 12	WSW-WNW.
Black Gull, Am. S. S.	Rotterdam	New York	[1] 50 34 N.	30 13 W.	13	Mdt, 13	14	27.93	SW	WSW, 11	NW	WSW, 11	SW-WSW-N.
Mobile City, Am. S. S.	Swansea	Portland, Maine	49 45 N.	25 10 W.	13	3a, 14	14	28.08	S	WSW, 10	NW	NW, 10	SW-NW.
Motocarline, Belg. M. S.	Antwerp	Baytown	43 52 N.	24 00 W.	13	4a, 14	15	[2] 29.26	WSW	WSW, 9	WNW	W, 10	WSW-W.
Pipestone County, Am. S. S.	New York	Havre	48 48 N.	25 32 W.	13	do	15	28.91	WSW	W, 11	NW	W, 11	WSW-WNW.
Sarcoxie, Am. S. S.	Bordeaux	New York	[1] 43 26 N.	22 24 W.	14	6a, 14	14	29.41	W	W, 9	WNW	W, 10	
Black Falcon, Am. S. S.	New York	Rotterdam	48 59 N.	23 07 W.	14	do	15	28.40	WSW	WSW, 9	WNW	WNW, 10	WSW-W.
Tymeric, Br. S. S.	Port Royal	Liverpool	48 13 N.	23 50 W.	13	do	15	28.42	WSW	WSW, 12	NW	WSW, 12	WSW-W.
Jamaica Producer, Br. S. S.	Kingston	Rotterdam	49 24 N.	14 36 W.	13	Noon, 14	15	28.45	WSW	SW, 10	W	SW, 10	WSW-SW-WSW.
General Gassouin, Fr. M. S.	New York	Antwerp	48 55 N.	19 00 W.	13	do	15	28.40	W	WSW, 10	WNW	W, 12	SW-WNW.
New Brunswick, Br. S. S.	Freetown	Boston	35 52 N.	59 40 W.	13	3p, 14	16	29.66	SW	W, 7	NNW	NW, 12	W-NW.
Yuri Maru, Jap. S. S.	Schiedam	New York	49 50 N.	7 19 W.	14	6p. 14	15	28.35	SSW	SSW, 10	W	WSW, 12	SSW-SW.
Waban, Am. S. S.	New Orleans	London	35 05 N.	62 03 W.	15	8a, 15	16	29.79	NW	NW, 7	W	NW, 10	
Tabinta, Du. M. S.	Gibraltar	Halifax	35 48 N.	39 20 W.	16	8a, 16	16	29.59	SSW	S, 10	WNW	W, 11	S-WSW.
Lochkatrine, Br. M. S.	Cristobal	Liverpool	44 13 N.	40 16 W.	16	2p, 16	17	28.49	SE	WSW, 10	WNW	WSW, 12	SSW-WSW.
West Eldara, Am. S. S.	Antwerp	Boston	49 17 N.	36 52 W.	16	9p, 16	17	28.12	E	NNE, 11	W	N, 11	E-NNE-N.
Pres. Harding, Am. S. S.	Southampton	New York	49 24 N.	23 00 W.	17	10a, 17	18	28.67	SW	SW, 10	SW	WNW, 11	
Tennessee, Dan. S. S.	Bremen	Norfolk	50 21 N.	12 47 W.	17	11a, 18	19	28.95	SW	W, 10	W	NW, 11	W-NW.
Waban, Am. S. S.	New Orleans	London	39 05 N.	45 10 W.	19	9a, 19	19	29.92	W	NW, 10	NW	NW, 10	
Caledonia, Br. S. S.	Glasgow	New York	41 12 N.	65 40 W.	20	4a, 20	20	29.24	SSE	S, 9	WNW	W, 10	S-SW.
Tabinta, Du. M. S.	Gibraltar	Halifax	42 19 N.	58 02 W.	20	2p, 20	21	29.32	S	SW, 11	WNW	S, 12	S-SW-W.
Sarcoxie, Am. S. S.	Bordeaux	New York	43 00 N.	45 30 W.	20	2a, 21	21	29.64	SSW	SW, 11	WNW	SW, 11	SW-WNW.
London Corporation, Br. S. S.	Philadelphia	Liverpool	40 04 N.	64 20 W.	22	2p, 22	24	29.83	ENE	ENE, 8	N	NNW, 10	ENE-NE.
Exarch, Am. S. S.	Casablanca	New York	36 18 N.	44 25 W.	23	1p, 23	24	[2] 29.30	SSW	SSW, 9	NW	WNW, 10	SSW-WNW-SW.
Mahronda, Br. S. S.	Boston	London	46 00 N.	37 43 W.	22	5p, 23	24	28.50	NW	N, 7	W	NE, 11	NE-N-W.
McKeesport, Am. S. S.	Havre	New York	44 50 N.	28 53 W.	23	1a, 24	26	28.43	W	SSW, 11	NNW	SSW, 12	S-SSW-WSW.
Tennessee, Dan. S. S.	Bremen	Norfolk	50 33 N.	30 30 W.	24	8a, 24	25	28.22	ESE	NE, 12	WNW	NE, 12	E-NE-NNW.
Black Heron, Am. S. S.	Antwerp	Boston	51 00 N.	23 00 W.	24	2p, 24	24	28.54	S	S, 10	SW	S, 12	Steady.
Minnequa, Am. S. S.	Copenhagen	New York	56 27 N.	27 40 W.	24	10p, 24	26	27.81	SE	SE, 10	SSW	SE, 10	SE-S.
China Arrow, Am. S. S.	Beaumont	Boston	35 50 N.	74 00 W.	26	3p, 26	27	29.81	NW	WNW, 6	NNW	NW, 9	SW-WNW-NW
City of Norfolk, Am. S. S.	Havre	Norfolk	49 40 N.	19 28 W.	26	4a, 27	27	28.75	S	SSW, 10	NW	SSW, 10	SSW-W.
Yaka, Am. S. S.	Mobile	Glasgow	43 46 N.	47 56 W.	28	Noon, 28	31	28.74	W	W, 8	S	W, 10	None.
Emanuel Nobel, Belg. S. S.	Antwerp	New York	43 42 N.	36 24 W.	28	9p, 28	29	28.85	S	W, 11	WSW	WNW, 11	W-WNW.
Gateway City, Am. S. S.	do	Mobile	37 37 N.	32 30 W.	28	Mdt. 28	29	29.59	S	SSW, 11	W	SSW, 11	SSW-WSW.
Exarch, Am. S. S.	Casablanca	New York	36 00 N.	62 00 W.	29	10p, 29	31	[2] 29.31	SW	SSW, 9	NNW	NW, 11	SSW-W.

OCEAN GALES AND STORMS, DECEMBER, 1934—Continued

Vessel	Voyage: From—	Voyage: To—	Position at time of lowest barometer: Latitude	Position at time of lowest barometer: Longitude	Gale began December—	Time of lowest barometer December—	Gale ended December—	Lowest barometer	Direction of wind when gale began	Direction and force of wind at time of lowest barometer	Direction of wind when gale ended	Direction and highest force of wind	Shifts of wind near time of lowest barometer
NORTH PACIFIC OCEAN			° ′	° ′				Inches					
Tarakan, Du. M. S.	Manila	Los Angeles	16 09 N.	125 31 E.	[3] 28	8p, 28 [3]	2	29.71	ENE	NE, 7	NE	ENE, 9	ENE-NE.
Comliebank, Br. M. S.	Sydney	Shanghai	9 20 N.	137 00 E.	[3] 30	1a, 1	1	28.81	NNW	NE, 12	SE	NE, 12	NNW-NE-SE.
Noumea, Pan. M. S.	Gingoog, P. I.	Los Angeles	12 05 N.	128 23 E.	1	5a, 2	2	29.32	NE	NW, 8	S	W, 11	NE-NW-W.
Irisbank, Br. M. S.	San Francisco	Manila	28 50 N.	161 30 W.	3	3p, 3	6	29.78	SSW	SSW, 6	WSW	W, 9	
Gen. Sherman, Am. S. S.	Yokohama	San Francisco	46 55 N.	155 26 W.	4	6a, 4	4	28.68	SE	SE, 8	SSW	SSE, 9	ENE-SE-SSE.
Pres. Adams, Am. S. S.	Honolulu	Kobe	[1] 29 04 N.	176 45 W.	4	11a, 4	4	29.67	W	W, 8	NW	NW, 9	WNW-NW.
Jefferson Myers, Am. S. S.	Yokohama	Portland, Oregon.	48 30 N.	160 28 W.	4	Noon, 4	4	28.44	NW	WNW, 9	SW	WNW, 9	NE-WNW-SW.
Comliebank, Br. M. S.	Sydney	Shanghai	[1] 21 41 N.	129 31 E.	4	6p, 4	6	29.28	SSW	SW, 9	NNW	N, 9	SW-N.
San Diego Maru, Jap. M. S.	Nigata	Los Angeles	46 11 N.	157 37 W.	5	6p, 5	6	28.28	WNW	WNW, 8	WSW	WSW, 10	N-WNW-WSW
Jefferson Myers, Am. S. S.	Yokohama	Portland, Oregon.	48 25 N.	153 50 W.	5	8p, 5	6	27.76	NE	SE, 11	S	ESE, 11	NE-SE-SW.
Heian Maru, Jap. M. S.	do	Vancouver	50 42 N.	159 36 W.	5	2a, 6	5	28.05	N	W, 3	NNW	NNW, 9	NNW-W-SW.
Siljestad, Nor. M. S.	Tokuyama	San Francisco	34 55 N.	169 00 E.	6	4a, 6	7	[2] 29.47	WNW	NE, 5	WNW	WNW, 10	E-NE-W.
Fernlane, Nor. M. S.	Los Angeles	Kobe	29 53 N.	176 26 E.	6	4p, 6	6	29.70	SW	SW, 9	SW	SW, 9	Steady.
Cities Service Kansas, Am. S. S.	Balboa	Los Angeles	14 40 N.	96 00 W.	5	do	6	29.75	N	N, 7	NE	NNE, 8	N-NNE.
San Diego Maru, Jap. M. S.	Nigata	do	45 38 N.	153 48 W.	6	6p, 6	7	27.94	ESE	SSE, 9	W	SW, 12	ESE-SSE-SW.
Jefferson Myers, Am. S. S.	Yokohoma	Portland, Oregon.	49 15 N.	150 00 W.	6	1a, 7	7	28.34	SE	S, 11	SW	S, 11	ESE-S.
Heian Maru, Jap. M. S.	do	Vancouver	51 00 N.	151 48 W.	6	do	7	28.13	ESE	SSE, 10	SSW	S, 11	ESE-SSE-S.
Siljestad, Nor. M. S.	Tokuyama	San Francisco	35 35 N.	175 00 E.	8	6a, 8	9	[2] 29.70	NW	W, 5	WNW	WNW, 9	WSW-WNW.
Pres. Jackson, Am. S. S.	Victoria	Yokohama	52 08 N.	147 26 W.	9	6a, 11	11	29.06	ESE	NE, 8	N	N, 9	E-NE-NNE.
Fernlane, Nor. M. S.	Los Angeles	Kobe	31 03 N.	158 40 E.	11	4a, 11	11	29.75	N	N, 9	N	N, 9	Steady.
California, Am. S. S.	Balboa	San Francisco	[1] 14 37 N.	92 53 W.	12	4a, 12	12	29.92	NNW	NNW, 2	N	NNW, 8	WNW-NNW.
Tacoma, Am. S. S.	Taku Bar	Seattle	50 11 N.	170 18 W.	12	4p, 13	13	28.35	E	S, 7	SSW	ENE, 9	ENE-S-SSW.
Pres. Jackson, Am. S. S.	Victoria	Yokohama	51 22 N.	173 56 W.	13	8p, 13	15	28.73	E	N, 9	NW	E, 10	ENE-N.
Elmsport, Am. S. S.	Balboa	Los Angeles	13 18 N.	94 22 W.	13	4p, 14	15	29.92	NNW	NNE, 7	NE	NNE, 8	None.
Golden Peak, Am. S. S.	Dairen	San Francisco	39 00 N.	156 40 E.	14	9p, 14	14	29.46	SSW	SSW, 9	SW	SSW, 9	SSW-SW.
Zuiyo Maru, Jap. S. S.	Tokuyama	Los Angeles	38 32 N.	171 00 E.	16	8p, 15	16	29.53	WSW	SW, 7	WNW	WNW, 10	S-SW-WSW.
Hiye Maru, Jap. M. S.	Vancouver	Yokohama	46 49 N.	160 46 E.	17	2p, 17	17	29.45	NW	WNW, 7	NW	NW, 9	WNW-NW.
Zuiyo Maru, Jap. S. S.	Tokuyama	Los Angeles	38 40 N.	175 30 W.	17	8a, 17	17	28.67	NE	N, 11	WNW	N, 11	ENE-NE-N.
Golden Dragon, Am. S. S.	San Francisco	Yokohama	34 29 N.	170 18 W.	17	10a, 17	17	29.45	S	S, 12	W	S, 12	SSE-S-WSW.
Noumea, Pan. M. S.	Gingoog	Los Angeles	35 10 N.	178 30 E.	17	Mdt, 17	18	28.79	E	SW, 3	NNW	N, 10	E-SW-N.
Sanyo Maru, Jap. M. S.	Los Angeles	Yokohama	47 02 N.	154 00 W.	18	Noon, 18	19	29.37	SW	SW, 9	W	SW, 10	Steady.
Pres. Jackson, Am. S. S.	Victoria	do	42 30 N.	151 00 E.	19	10p, 18	20	29.45	WNW	SSW, 6	NW	W, 10	S-WSW.
Pres. McKinley, Am. S. S.	do	do	49 42 N.	131 12 W.	23	3p, 23	24	29.74	WNW	WNW, 6	WNW	WNW, 9	None.
Sanyo Maru, Jap. M. S.	Los Angeles	do	46 24 N.	168 12 E.	24	Mdt, 24	25	29.60	S	S, 9	SW	S, 9	
Golden Dragon, Am. S. S.	San Francisco	do	34 19 N.	161 17 E.	25	4p, 25	25	29.63	S	S, 11	WNW	S, 11	S-W.
Atlantic, Am. S. S.	Balboa	Los Angeles	16 00 N.	95 20 W.	26	3p, 26	26	29.80	N	NNE, 8	NNE	NNE, 8	NNW-NNE-W
Aorangi, Br. M. S.	Honolulu	Victoria	40 25 N.	131 52 W.	25	6p, 26	26	29.57	WNW	WNW, 6	NNW	NW, 8	NNW-W.
Sanyo Maru, Jap. M. S.	Los Angeles	Yokohama	42 31 N.	155 32 E.	26	11p, 26	27	29.29	N	N, 8	N	N, 8	
Noumea, Pan. M. S.	Gingoog	Los Angeles	36 10 N.	135 55 W.	26	11a, 27	28	29.95	NW	NW, 8	NNW	NW, 8	Steady.
Gen. Sherman, Am. S. S.	Portland, Oregon.	Yokohama	49 34 N.	174 02 E.	28	2p, 28	28	29.80	SW	SW, 8	SW	SW, 9	SW-WSW.
San Angelo, Am. S. S.	do	San Francisco	45 27 N.	124 20 W.	28	do	29	29.40	SW	SW, 7	SW	SW, 9	None.
Steelmaker, Am S. S.	Balboa	San Diego	15 18 N.	96 06 W.	28	6a, 29	29	29.78	NNW	NNE, 2	NNW	NNW, 8	W-NNE.
Tahchee, Br. S. S.	LosAngeles	Osaka	30 30 N.	145 00 E.	29	5p, 29	30	29.54	S	SW, 9	N	W, 10	S-SW-W.
Golden Dragon, Am. S. S.	San Francisco	Yokohama	34 21 N.	144 19 E.	29	1a, 30	30	29.49	ESE	N, 11	N	NE, 12	E-N.
Hakubasan Maru, Jap. M. S.	Yokohama	Los Angeles	38 29 N.	154 55 E.	30	7p, 30	31	29.12	NE	NW, 9	W	NW, 9	NE-NW-WNW
Tyndareus, Br. S. S.	do	Victoria	49 48 N.	172 18 W.	30	1p, 31	31	29.47	SSE	S, 6	SSE	SSE, 9	
Golden Star, Am. S. S.	do	San Francisco	40 18 N.	151 10 E.	30	4p, 30	31	29.83	N	N, 7	NNW	NNW, 9	NE-N-NNW.
Pres. McKinley, Am. S. S.	Victoria	Yokohama	46 32 N.	163 38 E.	31	4p, 31	[4] 1	28.59	ENE	N, 10	WNW	N, 12	E-N.

[1] Position approximate. [2] Barometer uncorrected. [3] November. [4] January.

NORTH PACIFIC OCEAN, DECEMBER 1934

By WILLIS E. HURD

Atmospheric pressure.—The entire central part of the North Pacific Ocean from the tropic south of Midway Island northward through Bering Sea was mostly dominated by low pressure, the average center of which lay in the neighborhood of the eastern Aleutians. Pressures throughout this region were somewhat below the normal; but from Kodiak Island, eastward and southward along the American coast, the barometer was somewhat above the normal, with the point of greatest departure, +.11, at Juneau.

The eastern oceanic anticyclone, central off the California coast, was more than usually restricted in area for the month, due to the encroachments of the low-pressure areas from the northwestward. In Asiatic waters high pressure not only covered the coasts from Hong Kong northward to the Kurils, but also extended eastward far into the ocean.

TABLE 1.—*Averages, departures, and extremes of atmospheric pressure at sea level, North Pacific Ocean, December 1934, at selected stations*

Stations	Average pressure	Departure from normal	Highest	Date	Lowest	Date
	Inches	*Inch*	*Inches*		*Inches*	
Point Barrow	29.94	−0.09	30.50	19	29.00	8
Dutch Harbor	29.52	−.04	30.64	26	28.18	6
St. Paul	29.52	−.06	30.40	27	28.56	2
Kodiak	29.63	+.07	30,40	25	29.18	6
Juneau	29.90	+.11	30.61	4	29.35	15
Tatoosh Island	30.03	+.07	30.64	4	28.82	25
San Francisco	30.16	+.04	30.49	17	29.79	27
Mazatlan	29.95	+.02	30.00	8, 13, 16, 19	29.88	28
Honolulu	30.00	−.01	30.14	18	29.79	1
Midway Island	29.99	−.02	30.28	20	29.68	6
Guam	29.84	−.08	29.94	10	29.60	3
Manila	29.86	.00	30.02	9	29.60	2
Hong Kong	30.08		30.33	6	29.91	27
Naha	30.08	.00	30.28	10	29.82	3
Chichishima	30.04	+.04	30.28	11	29.66	5
Nemuro	30.03		30.36	28	29.70	13

NOTE.—Data based on 1 daily observation only, except those for Juneau, Tatoosh Island, San Francisco, and Honolulu, which are based on 2 observations. Departures are computed from best available normals related to time of observation.

Cyclones and gales.—The greater number of the North Pacific cyclones of December 1934 were of oceanic origin, and fewer than the usual number of depressions of consequence for the season entered the sea from Asia. The most important of these few occurred at the end of the month, when a small cyclone of no great depth crossed Japan and, intensifying rapidly upon passing to sea, caused gales which attained a maximum force of 12 NE., late on the 29th, and of force 10–11 during the forenoon of the 30th, between Yokohama and longitude 145° E.

Practically all other gales occurring north of the Tropics, even those of the 19th, with force of 10, east of Hokushu, were associated with cyclonic activities which arose at sea and expanded eastward or westward during their fluctuations.

The month as a whole was stormy. Pressures well below 29 inches were recorded on several days; and gales exceeding force 10 were encountered on at least 8 days north of the 30th parallel.

On December 2 the Aleutian LOW began to spread and deepen. By the 4th a great low-pressure system extended from the east Bering Sea far southward, with barometer down to 29.72, accompanied by a west gale, and force 8, even at Midway Island, while in 48½° N., 160½° W., the American S.S. *Jefferson Myers* was experiencing a strong northwesterly gale, barometer 28.44. On the 5th this ship, when 4° farther eastward, ran into a south gale of force 11, with lowest pressure at the unusual value of 27.76 inches. The Japanese M.S. *San Diego Maru*, on the 6th, reported a pressure reading of 27.94 inches, in conjunction with a southwest hurricane, near 46° N., 154° W. Heavy gales and low pressures continued until early on the 7th, after which the weather moderated. The field of severest storminess and lowest pressures during the period 5th to 7th extended from the eastern Aleutians southeastward to about latitude 45° N., longitude 145° W.

On the 13th to 17th the LOW again deepened, and spread southward from Bering Sea toward Midway Island. Along the upper routes the wind attained forces of 9 and 10 south of the Aleutians in the early part of this period, with lowest observed pressure 28.35. On the 17th the heaviest winds (forces 11–12) were experienced along the middle routes north of Midway Island, between 180° and 170° W. On this date strong gales were encountered also to the eastward of the Kuril Islands on the northern route to Japan.

On the 25th the American S.S. *Golden Dragon*, San Francisco to Yokohama, experienced a south gale of force 11, near 34° N., 161° E., in connection with a cyclone of moderate depth in the neighborhood. This steamer on its westward voyage had the rather unique experience of not only weathering this severe gale of the 25th, but also of previously passing through the hurricane belt of the 17th north of Midway Island, and on the 29th and 30th of battling with the equally heavy cyclonic gales a day's voyage out from Yokohama.

Toward the end of December a local cyclone occurred off the Washington coast. It originated as a small depression near 49° N., 134° W., early on the 25th, and by midnight had so developed in intensity as to cause winds of force 11 at several coastal points. At North Head the extreme wind velocity on the 25th was 65 miles an hour from the south; at Tatoosh Island, it was 71 miles from south and southwest during the night of the 25th-26th, with a low barometer of 28.82 inches. The storm center hung off the coast until the 29th, and was accompanied on land by damaging rains. A few steamers reported gales of force 8–9 between the coast and 135° W., extending as far south as the thirty-fifth parallel, on the 26th to 28th.

At the close of the month a deep and extensive cyclone raged over much of the central-western part of the northern steamship route, with winds of force 11–12 reported between 45°–50° N., 160° E. and 170° W. The American S. S. *President McKinley*, in this storm, reported a pressure of 28.59 inches, accompanied by a north hurricane.

Typhoons.—In an accompanying report, the Rev. Fr. Doucette describes the typhoons and depressions in the Far East during December 1934. The typhoon of November 30–December 6 was the most intense of the month at sea; and in its early stages, on December 1, had attained full hurricane strength a short distance southwest of Yap, as shown by the report of the British M.S. *Comliebank*. The ship on that date had a low barometer reading of 28.81 inches. On the 2d, as the cyclone swept up to the eastward of the Philippine Islands, the Panaman M. S. *Noumea* experienced a wind of force 11 a short distance south of the center of the storm. The M. S. *Comliebank*, bound northwest toward Shanghai after her first encounter with the storm, again entered the storm area on the 4th, after the recurve. At this time the typhoon's energy had abated, and the highest wind velocity encountered by the ship was from the north, force 9.

Tehuantepecers.—Owing to the frequent extensions of anticyclones of the United States into the Gulf of Mexico, an unusual amount of norther-type weather occurred in the Gulf of Tehuantepec. While the induced gales were not heavy, yet northerly winds of force 8 were experienced in the Gulf on the 6th, 12th, 14th, 20th, 26th, and 29th.

Fog.—Fog was of very little meteorological importance this month. It occurred on 4 days off the southern and Lower California coasts, and on a few days in widely scattered areas elsewhere over the ocean.

TYPHOONS AND DEPRESSIONS OVER THE FAR EAST, NOVEMBER 1934

BERNARD F. DOUCETTE, S. J.

[Manila Observatory]

During November 1934, there were two typhoons and one depression over the regions of the Far East. The last few days of the month saw a typhoon form over the Caroline Islands and move toward the archipelago, crossing the islands in December.

Depression, November 1 to 6.—The depression formed November 1 in the Pacific Ocean between Palau Island and Mindanao. It moved northwest, then west (Nov. 3) across the Visayan Islands and northern Palawan. November 4 found it in the China Sea, where it changed its course to west-northwest, entering Indo-China November 6.

Typhoon, November 10 to 19.—Forming over the eastern Caroline Islands, this typhoon appeared November 10 about 500 miles southeast of Guam. It moved rapidly on a west-northwest course, traversing the distance to the Philippines in 4 days. On the morning of the 14th, it was close to and approaching the northern part of Samar Island. Changing to a northwest course, it crossed Samar Island between Laoang and Calbayog, passed over Legaspi, Albay Province, then west of Naga, Camarines Sur, north of Atimonan, Tayabas Province, and approached Manila, the forenoon of the 15th. About noon it passed between Infanta, Tayabas Province, and Manila, at the same time decreasing in intensity. Moving northwest, it crossed the Provinces north of Manila. It was in the

China Sea the morning of the 16th, close to and west of the coast of Luzon. It was a very small center, within 70 miles of the coast, as the observations taken on board the S. S. *Anking* show. This ship, en route to Manila, followed the one hundred and nineteenth meridian very closely and yet passed west of the typhoon on the afternoon of the 17th. The next day, the typhoon was over the western part of the Balintang Channel, where it changed its course to the northeast, filling up over the Nansei (Loochoos) Islands, November 19.

At Legaspi, the minimum reading of the barometer was 723.45 millimeters (28.482 inches); at Naga, 728.87 millimeters (28.695 inches). The rains which this typhoon brought caused many deaths in and around the town of Mauban, Tayabas Province. Seventeen hours of rain over the sources of the Mauban River caused a sudden and destructive flood, which took a toll of 52 lives. The province of Tayabas suffered heavily and, on November 24, the Governor released the report that 106 lives were lost because of this typhoon.

Typhoon, November 24 to December 3.—This typhoon first appeared on the weather map of November 24, 2 p. m., located about 500 miles southeast of Guam. It moved west-northwest and then was almost stationary, November 25 and 26, over the regions about 300 miles south-southwest of Guam. Taking a more westerly course, it approached the island of Yap November 27, passing that island on a west by south course early in the forenoon of the same day. Moving very fast on a west by north course, it approached the Visayan Islands, being located on November 28 near latitude 10° N., longitude 131° E. November 29, at 6 a. m., it was close to and south of Tacloban, Leyte Province, now changing to a west-northwest course. Crossing the Visayan Islands, it moved southwest of Masbate, north of Capiz, close to and south of Odiongon. The next morning, (Nov. 30) it was over northern Mindoro. It continued its west-northwest course into the China Sea for 2 days. On December 2, it changed its course more to the west and filled up over the Paracel Islands the next day.

This storm was the cause of much destruction to crops and light-material houses; little loss of life was reported, except the case of the sinking of the M. S. *Pulupandan* which was lost off Pandan, Antique Province, about 6:30 p. m. November 29. Of the crew of 28, 7 were saved, according to the newspapers of December 5.

Of the stations reporting, Guiuan, Samar Province, reported the lowest barometric minimum, 724.80 millimeters (28.535 inches). Tacloban, Leyte Province reported 727.24 millimeters (28.631 inches).

TYPHOONS AND DEPRESSIONS IN THE FAR EAST, DECEMBER 1934

BERNARD F. DOUCETTE, S. J.

[Weather Bureau, Manila, P. I.]

Four typhoons and 1 depression, 2 of which were exceptional because of their courses, occurred during the month. We shall consider these in chronological order.

Typhoon, November 30 to December 6.—The approximate positions of this typhoon, day by day, were:

November 30, 6 a. m., latitude 8° N., longitude 142°30′ E.
December 1, 6 a. m., latitude 8°30′ N., longitude 135° E.
December 2, 6 a. m., latitude 12° N., longitude 128°30′ E.
December 3, 6 a. m., latitude 15°30′ N., longitude 124°30′ E.
December 4, 6 a. m., latitude 21°30′ N., longitude 129° E.
December 5, 6 a. m., latitude 26°30′ N., longitude 137° E.
December 6, 6 a. m., latitude 30° N., longitude 141° E.

This typhoon was severe. As it passed Yap, about 60 miles to the south, a barometric minimum of 742.3 millimeters (29.22 inches), was recorded, together with winds of force 9 from the east. On December 3, about 200 miles east of Luzon, it caused destructive rains in the Cagayan River Valley (northern Luzon). Also, on December 4 and 5, the northerly winds on the western side of the typhoon reinforced the circulation around the high-pressure area over China to such an extent that strong northeast monsoon winds extended as far as Singapore. The path of this typhoon was unusual for the time of year. The usual course of typhoons during the late months of the year is across the archipelago, so that one which recurves to the northeast is considered exceptional. It was very fortunate for the Philippines that this typhoon recurved and did not pass over any part of the Islands.

Typhoon, December 3 to 7.—This typhoon formed in the China Sea and moved eastward, decreasing in intensity as it crossed the archipelago. The daily positions are given below:

December 3, 6 a. m., latitude 10° N., long tude 116°30′ E.
December 4, 6 a. m., latitude 11° N., longitude 119° E.
December 5, 6 a. m., latitude 11° N., longitude 122° E.
December 6, 6 a. m., latitude 11° N., longitude 129° E.
December 7, 6 a. m., latitude 12° N., longitude 134° E.

Regarding the formation of this typhoon, there are two possibilities. The typhoon of November 24 to December 3 (briefly described in the typhoons of November 1934) was in the China Sea close to the same region where the present typhoon appeared. There were at the time northeast monsoon winds of considerable intensity over the China Sea, so the typhoon could not move very far on a westerly course; there is no definite evidence that it filled up, and so it is possible that it moved southward and appeared in the China Sea west of Palawan Island, centered in the position given above. On the other hand, from observations at Puerto Princesa, Palawan Island, and also observations taken on board the S. S. *Fathomer*, then in port at an island at the southern portion of the Palawan group, it seems to have been a new typhoon. It was considered merely a low-pressure area until the S. S. *Halili* sent observations which definitely proved that it was a typhoon. Its eastward course was not rapid, and, fortunately it decreased in intensity as it moved. It caused great destruction in the town of Bacuit, Palawan Province. Its path across the Visayan Islands was along a well-defined front, between the northeast monsoon and the southwest monsoon, as it is called. The surface and cloud observations from the stations in the Philippines together with pilot balloon reports received by radio from Singapore and Alor Star gave clear evidence of the existence of this front. The typhoon moved with the warmer current of air.

A few words concerning the general situation during these days might be of interest. From November 20 on, the high pressure over China became stronger, then weaker, then stronger, Then the typhoon of November 24 to December 3 formed and moved across the archipelago. Following it was the very severe typhoon described above, which, however, recurved. When it reached the ocean area east of northern Luzon and Formosa, it caused the northeast monsoon to intensify. In the China Sea, this prevented the typhoon which had just crossed the Visayan Islands (Nov. 29 and 30) from moving in a westerly direction. It moved more slowly and seemed to be filling up. Then, a typhoon appeared west of northern Palawan (Dec. 3, lat. 10°, long. 116°30′) and began to move in an easterly direction. In advance of it was the well-defined front, and its course was practically that of the boundary between the two wind systems. When this typhoon moved into the Pacific Ocean,

the northeast monsoon prevailed over the whole archipelago.

Typhoon, December 4 to 7.—This typhoon formed so far to the east of the Philippines and moved in such a way that it had no effect upon the weather of the archipelago The approximate daily positions are given below:

December 4, 6 a. m., latitude 10° N., longitude 144° E.
December 5, 6 a. m., latitude 15° N., longitude 140° E.
December 6, 6 a. m., latitude 22° N., longitude 140° E.
December 7, 6 a. m., latitude 26° N., longitude 147° E.

Typhoon, December 12 to 18.—Forming southwest of Palau Island, this disturbance moved toward the archipelago as a depression, increasing in intensity as it moved. It was strong enough on December 13 and 14 to be called a typhoon, and then it weakened and slowly filled up. The positions of this typhoon are given below:

December 12, 6 a. m., latitude 5° N., longitude 133° E.
December 13, 6 a. m., latitude 8°20′ N., longitude 129°30′ E.
December 14, 6 a. m., latitude 10° N., longitude 125° E.
December 15, 6 a. m., latitude 10°30′ N., longitude 123° E.
December 16, 6 a. m., latitude 12°20′ N., longitude 122°30′ E.
December 17, 6 a. m., latitude 12°20′ N., longitude 121°30′ E.
December 18, 6 a. m., latitude 11°30′ N., longitude 117° E.

Depression, December 16 to 19.—This depression formed southwest of Yap and moved toward the Philippines, but lost what little energy it had before reaching the archipelago. Its approximate positions are given below:

December 16, 6 a. m., latitude 7° N., longitude 137° E.
December 17, 6 a. m., latitude 8° 30′ N., longitude 135°30′ E.
December 18, 6 a. m., latitude 10° N., longitude 132° E.
December 19, 6 a. m., latitude 10°20′ N., longitude 130°30′ E.

GALE IN THE RED SEA, NOVEMBER 1934

In the meteorological report received at the Weather Bureau from the British S. S. *Ramsay*, Capt. W. Shaw Hickman, master, Second Officer R. S. McLean, observer, is a description of a violent gale experienced on November 18, 1934, while northbound in the Red Sea. The ship at midnight (17th–18th) was in latitude 23°12′ N., longitude 36°48′ E., wind east-southeast, force 4, barometer 29.98 inches (uncorrected). At 1:15 a.m. the wind suddenly shifted to north-northeast, force 9, accompanied by heavy rain and thunder. At 2 a.m. the wind force rose to 10, with barometer steady at 29.98.

After 1:15 a.m., according to Mr. McLean, "the sea rose very quickly and the steamer commenced shipping water fore and aft, while spraying over all. At times heavy spray was thrown clear over top of chart room on top of bridge. The lookout man had to leave the forecastle head and take up position on the bridge, it being dangerous forward on account of sea rising so rapidly." By 2:10 a. m. the wind had decreased to northeast, force 4.

The observing officer referred to the stormy conditions as of exceptional character; and also drew attention to a thunderstorm experienced 12 hours previously, on the 17th, in which the wind, which was from a northerly direction, force 2, at noon "shifted suddenly with one leap" to south-southwest, force 6, at 1:35 p.m.

The two instances were mentioned as squalls extraordinary to this region, and moving in diametrically opposite directions. The pressure throughout remained at 29.98 inches.—W. E. H.

CLIMATOLOGICAL TABLES

CONDENSED CLIMATOLOGICAL SUMMARY

In the following table are given for the various sections of the climatological service of the Weather Bureau the monthly average temperature and total rainfall; the stations reporting the highest and lowest temperatures, with dates of occurrence; the stations reporting the greatest and least total precipitation; and other data as indicated by the several headings.

The mean temperature for each section, the highest and lowest temperatures, the average precipitation, and the greatest and least monthly amounts are found by using all trustworthy records available.

The mean departures from normal temperatures and precipitation are based only on records from stations that have 10 or more years of observations. Of course, the number of such records is smaller than the total number of stations.

Condensed climatological summary of temperature and precipitation by sections, December 1934

[For description of tables and charts, see Review, January, p. 37]

Section	Temperature								Precipitation					
	Section average	Departure from the normal	Monthly extremes						Section average	Departure from the normal	Greatest monthly		Least monthly	
			Station	Highest	Date	Station	Lowest	Date			Station	Amount	Station	Amount
	°F.	°F.		°F.			°F.		In.	In.		In.		In.
Alabama	46.7	−0.9	Pushmataha	80	30	Valley Head	10	12	3.41	−1.51	Milltown	6.76	Valley Head	1.83
Arizona	46.8	+2.3	Marinette	85	11	2 stations	0	3	1.71	+.51	Crown King	4.18	Gila Bend	.11
Arkansas	41.5	−1.2	Portland	74	24	Dutton	4	11	3.78	−.51	England	6.85	Bentonville	.95
California	46.3	+.7	2 stations	83	[1] 10	Sierraville	−12	31	3.20	−.50	Crescent City (near)	13.53	Brawley	.09
Colorado	28.9	+3.5	Two Buttes	79	22	Fraser	−24	4	.60	−.31	Columbine	3.13	6 stations	.00
Florida	60.0	.0	Lake Placid	90	[1] 3	2 stations	16	12	1.00	−1.76	Pensacola	2.56	Everglades	.00
Georgia	46.9	−1.2	2 stations	82	[1] 3	3 stations	10	12	2.64	−1.62	Fort Gaines	6.02	Waycross	.88
Idaho	27.7	+1.8	Lewiston	62	19	Deadwood	−17	1	2.03	+.05	Roland	9.78	Challis	.09
Illinois	28.3	−2.2	Du Quoin	59	4	Sycamore	−9	27	1.74	−.52	Cairo	3.30	Warsaw	.66
Indiana	29.9	−2.4	Shoals	60	2	Fowler	−12	27	2.00	−.88	Scottsburg	3.81	Shoals	1.08
Iowa	21.5	−2.4	Sioux City	48	22	4 stations	−17	[1] 11	.57	−.62	Clinton	2.01	Mt. Ayr	T
Kansas	33.1	+.3	Liberal	72	28	Hanover	−5	7	.42	−.44	Eldorado	1.35	2 stations	.00
Kentucky	37.0	−.9	Middlesboro	69	1	Anchorage	5	12	2.18	−1.80	Lovelaceville	4.22	Whitesburg	.83
Louisiana	52.8	+.4	2 stations	82	[1] 30	2 stations	14	12	3.91	−1.47	Dodson	7.69	Jonesville	1.91
Maryland-Delaware	35.2	−.2	do	71	1	Oakland, Md	−16	11	2.75	−.40	State Sanatorium, Md.	4.71	Western Port, Md	1.59
Michigan	23.4	−1.8	Webber Dam	66	1	Vanderbilt	−22	30	1.59	−.49	Painesdale	5.09	Lake City	.48
Minnesota	11.8	−3.7	4 stations	45	12	2 stations	−40	26	.95	+.16	Reads	2.60	Willmar	.24
Mississippi	47.8	−.6	5 stations	80	[1] 30	do	12	[1] 11	4.53	−.81	Rosedale	7.29	Pontotoc	1.53
Missouri	31.6	−2.5	Garber	69	28	Downing	−3	26	1.66	−.41	Campbell	4.12	Unionville	.05
Montana	24.0	+1.1	Grass Range	67	11	Medicine Lake	−40	26	.91	+.02	Haugan	6.83	Four Buttes	.03

[1] Other dates also.

Condensed climatological summary of temperature and precipitation by sections, December 1934—Continued.

[For description of tables and charts, see Review, January, p. 37]

Section	Temperature								Precipitation					
	Section average	Departure from the normal	Monthly extremes						Section average	Departure from the normal	Greatest monthly		Least monthly	
			Station	Highest	Date	Station	Lowest	Date			Station	Amount	Station	Amount
	°F.	°F.		°F.			°F.		In.	In.		In.		In.
Nebraska	26.6	+0.1	Benkleman	70	12	2 stations	-14	7	0.49	-0.21	Arden (near)	1.37	Lodgepole	0.02
Nevada	34.1	+3.4	Logandale	75	[1] 11	Canyon Creek Ranch	-9	9	.92	-.06	Marlette Lake	2.64	Thorne	.24
New England	23.8	-2.7	Haverhill, Mass	70	1	East Barnet, Vt.	-26	31	3.34	+.01	Pinkham Notch, N. H.	6.02	Boston, Mass	1.64
New Jersey	33.2	-.5	2 stations	69	1	Runyon	-3	12	2.90	-.75	Little Falls	4.11	Layton	1.89
New Mexico	35.9	+2.0	Carlsbad	81	28	Seisor Ranch	-22	2	.47	-.22	Cloudcroft	2.28	18 stations	.00
New York	24.1	-2.7	3 stations	67	1	Stillwater Reservoir	-31	31	2.79	-.14	Trenton Falls	5.58	Elmira	1.15
North Carolina	41.9	-.8	2 stations	75	1	Mount Mitchell	-9	12	2.85	-.99	Beaufort	6.98	Hot Springs	1.32
North Dakota	12.6	.0	do	53	11	2 stations	-44	26	.30	-.22	Park River	1.19	Wishek	.00
Ohio	30.3	-1.4	do	74	1	Paulding	-12	27	1.44	-1.32	Wilmington	2.43	Cambridge	.70
Oklahoma	41.0	+1.3	Boise City	77	28	Hooker	7	7	.72	-.97	Idabel	3.41	Boise City	T
Oregon	34.6	+1.3	Port Orford	78	2	Danner	-10	28	4.52	+.71	Crossett	18.12	Valley Falls	.48
Pennsylvania	30.7	-.4	New Castle	73	1	Somerset	-10	11	2.55	-.61	Lansford	5.63	McKeesport	.84
South Carolina	44.8	-2.0	Garnett	78	3	3 stations	8	12	2.74	-.89	Crescent	5.80	Ferguson	1.00
South Dakota	21.7	+1.0	Rapid City	63	11	2 stations	-25	26	.30	-.27	Dumont	.93	2 stations	T
Tennessee	39.5	-1.3	Rogersville	70	1	Elkmont	-4	12	2.85	-1.77	Memphis	5.37	Fayetteville	1.38
Texas	51.0	+1.5	Mission	91	29	Sanderson	11	1	1.82	-.37	Lufkin	7.14	15 stations	.00
Utah	29.6	+3.2	Springdale	67	11	Thistle	-10	5	1.20	+.12	Silver Lake	5.29	Lucin	.02
Virginia	37.7	-.5	Diamond Springs	78	1	Hot Springs	1	11	2.63	-.47	Mount Weather	5.04	Timberville	.68
Washington	35.3	+1.1	Longview	66	3	2 stations	-6	27	6.20	+.73	Mt. Baker Lodge	30.00	Hanford	.50
West Virginia	33.5	-1.2	Sutton	78	1	do	-8	11	2.20	-1.14	Pickens	5.06	Dam No. 26 O. R.	.82
Wisconsin	17.0	-2.4	Lake Mills	54	1	Danbury	-29	26	1.29	-.03	Cornucopia	3.89	Viroqua	.45
Wyoming	23.8	+2.2	Pine Bluffs	66	11	South Pass City	-19	3	.74	-.01	Bechler River	6.35	Basin	T
Alaska (November)	16.7	+1.7	Ketchikan	60	25	2 stations	-28	[1] 13	1.84	-.95	View Cove	16.46	2 stations	T
Hawaii	71.6	+1.7	2 stations	90	[1] 12	Kanalohuluhulu	43	1	6.06	-4.00	Puhonua	29.50	Olowalu	.24
Puerto Rico	74.5	+.1	San German	94	24	Guineo Reservoir	48	25	8.90	+4.40	Rio Blanco	21.42	Santa Rita	.42

[1] Other dates also.

TABLE 1.—*Climatological data for Weather Bureau stations, December 1934*

[Compiled by Annie E. Small]

District and station	Elevation of instruments			Pressure			Temperature of the air										Mean wet thermometer	Mean temperature of the dew point	Mean relative humidity	Precipitation			Wind					Clear days	Partly cloudy days	Cloudy days	Average cloudiness, tenths	Total snowfall	Snow, sleet, and ice on ground at end of month
	Barometer above sea level	Thermometer above ground	Anemometer above ground	Station, reduced to mean of 24 hours	Sea level, reduced to mean of 24 hours	Departure from normal	Mean max. + mean min. ÷ 2	Departure from normal	Maximum	Date	Mean maximum	Minimum	Date	Mean minimum	Greatest daily range				Total	Departure from normal	Days with .01, or more	Total movement	Prevailing direction	Maximum velocity: Miles per hour	Direction	Date						
	Ft.	Ft.	Ft.	In.	In.	In.	°F.	°F.	°F		°F	°F.		°F	°F.	°F.	°F.	%	In.	In.		Miles								0-10	In.	In.
New England							26.3	-3.2										69	3.04	-0.4										5.9		
Eastport	76	67	85	29.85	29.94	-0.04	20.9	-5.4	56	1	28	1	28	14	33	18	14	75	2.70	-1.0	9	9,780	nw.	51	se.	20	9	9	13	5.7	8.1	3.6
Greenville, Maine	1,070	6	40	28.73	29.97	...	14.2	...	57	1	22	-10	28	6	38	...	...	...	3.46	...	11	7,910	nw.	36	...	27	10	12	9	...	23.5	14.0
Portland, Maine	103	82	117	29.87	30.00	-.03	25.0	-2.6	57	1	32	3	9	18	32	21	16	70	3.90	-.1	12	7,309	n.	48	se.	19	15	7	9	4.2	10.8	6.3
Concord	289	60	...	...	...	...	24.2	-2.6	64	1	32	1	9	16	...	...	...	...	3.37	+.2	12	...	nw.	...	...	...	12	3	16	...	8.7	...
Burlington	403	11	48	29.57	30.04	-.01	17.4	-7.0	64	1	26	-12	23	9	41	...	...	...	2.68	+.8	15	8,195	nw.	38	se.	19	6	4	21	7.4	19.8	9.2
Northfield	876	12	60	29.04	30.04	-.01	15.6	-4.8	63	1	26	-18	31	5	38	13	10	82	2.29	-.2	14	5,550	n.	25	nw.	27	7	8	16	6.5	20.5	13.8
Boston	124	336	360	29.87	30.02	-.03	28.4	-4.1	65	1	36	3	9	21	25	24	16	60	1.64	-1.8	8	11,836	nw.	60	w.	26	10	9	12	5.7	1.6	.6
Nantucket	12	14	90	29.99	30.00	-.05	33.6	-2.2	58	1	39	11	9	28	22	30	25	72	3.48	-.3	8	11,605	nw.	44	sw.	20	8	6	17	6.1	.4	.0
Block Island	26	11	46	29.99	30.02	-.04	33.2	-2.8	60	1	39	12	9	27	22	30	24	70	3.52	-.3	8	14,880	nw.	57	nw.	27	7	11	13	6.2	1.2	.0
Providence	160	215	251	29.84	30.02	-.04	29.8	-1.8	64	1	37	5	9	23	29	26	17	61	3.10	-.3	8	9,531	nw.	51	nw.	27	14	7	10	5.0	.8	T
Hartford	159	70	104	...	30.06	-.01	29.6	-.2	64	1	36	8	11	23	29	...	...	...	3.36	-.6	10	6,735	nw.	...	...	...	9	8	14	...	.3	.0
New Haven	106	74	153	29.94	30.07	.00	31.2	-1.3	61	1	38	9	11	24	25	27	19	63	3.34	-.7	8	7,335	n.	32	s.	1	10	4	17	6.0	.1	.0
Middle Atlantic States							35.1	-0.5										68	2.46	-0.8										6.6		
Albany	97	107	115	29.96	30.07	-.01	26.0	-2.5	67	1	33	1	31	19	30	23	18	72	1.93	-.7	10	5,832	s.	27	sw.	26	6	7	18	7.0	3.8	.2
Binghamton	871	60	68	29.10	30.06	-.03	27.0	-1.2	65	1	34	3	31	20	32	...	...	...	2.35	.0	13	5,348	nw.	28	nw.	26	2	3	26	9.0	3.1	T
New York	314	415	454	29.72	30.07	-.02	33.4	-1.6	64	1	41	10	11	26	25	29	21	61	2.43	-1.2	8	12,632	nw.	58	nw.	26	11	7	13	5.6	T	.0
Bellefonte	1,050	5	42	28.93	30.08	...	27.4	...	65	1	35	1	11	20	28	25	22	80	1.89	...	10	...	w.	...	...	...	4	6	21	7.9	2.8	T
Harrisburg	374	94	104	29.69	30.10	-.02	33.3	+.6	65	1	39	15	11	27	23	29	21	63	4.33	+1.3	10	6,169	w.	35	nw.	26	6	7	18	7.2	1.2	T
Philadelphia	114	168	367	29.98	30.10	-.01	35.9	-.4	67	1	43	16	11	29	25	30	22	58	2.61	-.8	9	9,410	n.	43	s.	1	8	10	13	6.4	T	.0
Reading	323	283	306	29.73	30.10	...	33.4	+1.2	67	1	40	13	10	27	24	29	23	66	2.30	-1.3	10	9,145	nw.	49	nw.	26	7	10	14	6.7	.9	.0
Scranton	805	72	104	29.18	30.08	-.02	29.1	-1.6	65	1	36	8	9	23	26	26	22	74	2.32	-.7	11	5,842	nw.	27	nw.	30	3	10	18	7.3	.7	.0
Atlantic City	52	37	172	30.04	30.10	.00	36.4	.0	60	1	44	12	12	29	23	32	26	68	2.79	-1.2	9	11,898	w.	53	se.	19	7	8	16	6.6	T	.0
Sandy Hook	22	10	57	30.05	30.07	...	33.8	...	63	1	40	14	11	28	23	30	25	70	2.30	-1.7	8	11,829	nw.	43	nw.	26	9	7	15	6.4	T	.0
Trenton	190	88	106	29.88	30.09	...	33.3	-1.1	67	1	40	11	11	26	29	29	23	69	2.37	-1.0	10	7,548	nw.	32	nw.	26	8	9	14	5.8	T	.7
Baltimore	123	100	215	29.97	30.10	-.03	37.7	+.5	67	1	44	17	11	31	26	32	25	64	3.10	-.3	9	7,781	sw.	38	sw.	20	8	9	14	6.3	.1	T
Washington	112	62	85	29.99	30.12	-.01	37.3	+.7	68	1	45	17	12	30	26	32	25	64	2.91	-.4	8	5,583	nw.	25	nw.	26	8	9	14	6.1	3.0	.5
Cape Henry	18	8	54	30.09	30.11	...	42.6	-1.1	73	1	50	22	11	36	26	38	33	74	1.78	-1.7	10	9,960	n.	41	n.	11	8	9	14	6.0	1.0	.0
Lynchburg	686	5	...	29.05	30.14	.00	39.0	-.5	68	26	49	10	11	29	32	...	...	...	2.99	-.3	14	...	nw.	...	...	...	7	17	7	...	4.0	.5
Norfolk	91	80	125	30.03	30.14	+.01	43.0	-.1	71	1	50	19	12	36	25	37	32	71	1.83	-1.5	10	7,614	w.	30	w.	19	7	9	15	6.6	2.5	.0
Richmond	144	11	52	29.98	30.14	.00	39.6	-.2	68	1	49	14	12	30	26	33	28	70	2.32	-1.0	10	6,222	sw.	30	w.	1	14	5	12	5.3	3.9	.7
Wytheville	2,304	49	55	...	30.16	+.01	34.4	-.9	58	1	42	8	12	27	33	...	...	72	1.50	-1.4	11	5,798	w.	34	w.	19	8	10	13	...	2.4	.0
South Atlantic States							46.3	-1.0										74	2.44	-1.0										5.9		
Asheville	2,253	89	104	27.75	30.19	+.03	37.2	-.6	64	25	46	8	12	28	38	32	27	73	1.78	-1.4	11	6,954	nw.	26	w.	19	7	10	14	6.3	.6	.0
Charlotte	779	63	86	29.30	30.16	.00	42.2	-.8	67	1	51	18	12	34	30	36	30	67	3.29	-.6	10	5,279	ne.	27	sw.	1	11	7	13	5.8	T	.0
Greensboro	886	6	56	29.17	30.15	...	38.8	...	66	1	49	15	11	29	36	33	28	74	2.91	...	11	5,687	sw.	29	sw.	1	7	9	15	6.5	.2	.0
Hatteras	11	5	50	30.10	30.11	-.02	47.4	-2.7	72	1	54	25	12	41	26	44	42	85	4.07	-.1	11	10,342	n.	37	s.	1	10	5	16	6.2	T	.0

TABLE 1.—*Climatological data for Weather Bureau stations, December 1934*—Continued

District and station	Elevation of instruments: Barometer above sea level	Elevation of instruments: Thermometer above ground	Elevation of instruments: Anemometer above ground	Pressure: Station, reduced to mean of 24 hours	Pressure: Sea level, reduced to mean of 24 hours	Pressure: Departure from normal	Temperature of the air: Mean max. + mean min. ÷ 2	Temperature of the air: Departure from normal	Temperature of the air: Maximum	Temperature of the air: Date	Temperature of the air: Mean maximum	Temperature of the air: Minimum	Temperature of the air: Date	Temperature of the air: Mean minimum	Temperature of the air: Greatest daily range	Mean wet thermometer	Mean temperature of the dew point	Mean relative humidity	Precipitation: Total	Precipitation: Departure from normal	Precipitation: Days with .01, or more	Wind: Total movement	Wind: Prevailing direction	Wind: Maximum velocity: Miles per hour	Wind: Maximum velocity: Direction	Wind: Maximum velocity: Date	Clear days	Partly cloudy days	Cloudy days	Average cloudiness, tenths	Total snowfall	Snow, sleet, and ice on ground at end of month
South Atlantic States—Continued	Ft.	Ft.	Ft.	In.	In.	In.	°F	°F	°F		°F	°F		°F	°F	°F	°F	%	In.	In.		Miles								0-10	In.	In.
Raleigh	376	108	146	29.72	30.14	−0.01	42.6	−0.4	69	1	51	18	12	34	27	37	31	70	2.32	−1.3	12	6,537	nw.	27	nw.	26	10	7	14	5.8	0.4	0.0
Wilmington	72	73	107	30.07	30.15	.00	47.2	−1.9	70	4	56	22	12	38	29	42	37	73	3.00	+.2	12	6,348	ne.	29	sw.	19	11	5	15	5.9	T	.0
Charleston	48	11	92	30.10	30.15	.00	50.2	−1.5	72	26	58	23	12	42	25	45	41	75	2.16	−.6	11	7,521	w.	29	e.	30	8	9	14	5.7	T	.0
Columbia, S. C.	351	41	57	29.77	30.17	+.01	45.6	−1.6	69	25	55	19	12	36	31	40	36	76	2.29	−.7	12	5,127	ne.	24	w.	19	10	9	12	5.2	T	.0
Greenville, S. C.	1,039	139	------	------	------	------	42.8	+.6	70	1	52	17	12	34	30	------	------	------	3.41	−1.4	11	------	ne.	------	------	------	15	6	10	------	T	.0
Augusta	182	62	77	29.96	30.16	.00	46.6	−1.5	72	3	56	20	12	37	33	40	34	68	2.30	−.9	12	4,414	nw.	21	nw.	19	10	9	12	5.7	.0	.0
Savannah	65	73	152	30.09	30.16	+.01	52.0	−.4	75	3	61	22	12	42	27	45	40	74	1.46	−1.5	8	7,866	w.	34	w.	19	10	8	13	5.6	.0	.0
Jacksonville	43	86	110	30.11	30.16	+.02	55.7	−.6	80	3	65	23	12	46	30	49	45	76	.70	−2.3	7	5,926	nw.	25	w.	19	8	9	14	6.0	T	.0
Florida Peninsula							67.2	+0.7										79	0.76	−1.1										4.9		
Key West	22	10	64	30.08	30.10	+.02	71.0	+.7	83	4	76	45	12	66	23	65	63	82	.41	−1.3	6	7,204	ne.	32	nw.	11	10	12	9	5.3	.0	.0
Miami	25	124	168	30.10	30.13	+.02	68.6	+.6	83	1	76	30	12	62	32	62	59	76	.97	−.7	10	7,130	e.	25	nw.	11	10	13	8	5.1	.0	.0
Tampa	35	88	197	30.11	30.15	+.03	62.0	+.9	83	3	72	27	12	52	33	55	52	79	.91	−1.2	5	7,546	n.	28	n.	11	15	10	6	4.3	T	.0
Titusville	43	5	36	30.09	30.14	------	61.0	------	84	3	72	23	12	49	38	------	------	------	.63	------	5	------	nw.	------	------	------	10	13	8	------	.0	.0
East Gulf States							48.7	−0.8										76	2.94	−1.9										5.5		
Atlanta*	1,173	128	135	29.11	30.17	+.01	41.4	−3.3	64	25	50	18	12	33	31	37	33	78	2.42	−2.3	13	6,528	nw.	28	nw.	7	11	5	15	6.0	.1	T
Macon	370	79	87	29.78	30.18	+.02	45.8	−1.7	70	3	56	19	12	36	36	40	34	70	1.56	−2.4	13	5,100	nw.	24	w.	19	11	6	14	5.5	T	.0
Thomasville	273	49	58	29.88	30.19	+.04	52.8	+.3	77	25	64	20	12	42	35	46	42	78	1.61	−2.7	10	------	nw.	------	------	------	9	8	14	------	.0	.0
Apalachicola	35	11	51	30.13	30.17	------	54.0	------	74	30	61	24	12	47	27	49	------	------	.84	−4.3	8	------	n.	------	------	------	10	7	14	------	.0	.0
Pensacola	56	149	185	30.12	30.18	+.03	53.0	−1.0	73	26	60	25	12	46	24	49	45	80	2.56	−2.1	11	8,776	n.	34	se.	27	13	4	14	4.8	.0	.0
Anniston	741	9	------	------	------	------	44.5	+.3	70	25	53	14	12	36	31	------	------	------	4.03	−1.0	8	------	nw.	------	------	------	7	9	15	------	T	.0
Birmingham	700	11	48	29.39	30.18	+.02	44.8	−1.6	67	30	53	17	12	36	27	40	35	73	3.52	−1.6	12	5,463	nw.	25	w.	19	8	9	14	6.2	T	.0
Mobile	57	125	161	30.11	30.17	+.02	51.6	−.6	74	30	60	24	12	43	29	47	44	80	2.93	−2.0	10	6,619	n.	42	se.	27	12	5	14	5.1	.0	.0
Montgomery	218	92	105	29.94	30.20	+.04	47.6	−1.8	69	16	56	20	12	39	30	42	37	73	2.83	−2.0	12	5,142	n.	25	w.	19	11	5	15	6.2	T	.0
Meridian	375	67	92	29.77	30.18	+.02	47.8	+.1	76	30	58	18	12	38	35	42	38	76	5.04	−.2	11	4,455	sw.	24	nw.	19	11	7	13	5.5	T	.0
Vicksburg	247	65	73	29.92	30.19	+.04	50.0	.0	73	31	59	21	12	41	27	44	40	75	6.01	+.7	9	5,714	n.	27	w.	19	11	8	12	5.5	.0	.0
New Orleans	53	76	84	30.12	30.18	+.05	56.0	+.4	78	30	64	29	11	48	25	50	47	77	1.96	−2.8	8	4,906	ne.	20	se.	27	14	9	8	4.5	.0	.0
West Gulf States							51.7	+1.3										75	2.86	−0.2										5.4		
Shreveport	249	92	227	29.90	30.18	+.05	50.0	+.9	71	16	59	23	11	41	29	45	40	74	4.06	−.2	8	8,303	nw.	41	nw.	18	14	6	11	4.7	.0	.0
Bentonville	1,303	11	44	28.72	30.12	−.01	37.2	−.3	57	28	46	10	11	29	26	------	------	------	.95	------	6	5,321	sw.	20	s.	15	8	10	13	------	.5	.0
Fort Smith	457	79	94	29.66	30.16	+.03	41.0	−1.1	62	22	49	19	11	33	31	36	31	74	1.06	−1.7	8	6,366	e.	22	w.	3	10	9	12	5.5	T	.0
Little Rock	357	94	102	29.79	30.18	+.04	42.2	−2.0	62	15	50	17	11	34	29	37	32	73	5.90	+1.8	10	5,994	sw.	24	sw.	12	9	8	14	6.0	T	.0
Austin	605	136	148	29.52	30.16	------	54.3	+3.3	75	25	64	29	12	45	34	48	43	72	3.72	+1.1	12	5,524	n.	38	nw.	18	11	6	14	5.7	.0	.0
Brownsville	57	88	96	30.05	30.10	------	64.2	+3.0	82	18	72	38	12	56	29	58	55	79	1.18	−.4	7	7,943	se.	30	n.	3	10	13	8	5.6	.0	.0
Corpus Christi	20	11	78	30.12	30.14	+.02	60.2	+2.2	80	29	68	37	8	53	28	55	52	79	.70	−.8	4	7,492	s.	30	n.	31	9	10	12	5.9	.0	.0
Dallas	512	220	227	29.60	30.16	------	48.4	------	77	29	58	22	11	39	34	42	36	66	.88	−1.5	4	8,219	se.	41	nw.	18	14	5	12	5.2	.0	.0
Fort Worth	679	92	110	29.43	30.16	+.04	49.7	+2.2	79	29	60	24	11	39	37	------	------	------	.56	−1.3	4	7,010	n.	37	n.	18	15	5	11	4.5	.0	.0
Galveston	54	106	114	30.11	30.17	+.05	57.4	+1.0	73	31	63	33	11	52	21	53	50	81	3.42	−.3	9	7,668	n.	38	nw.	18	13	6	12	5.2	.0	.0
Houston	138	292	314	30.02	30.17	------	56.8	+2.4	78	31	65	28	11	48	28	------	------	------	4.04	−.2	11	8,643	se.	43	se.	2	12	6	13	5.3	.0	.0
Palestine	510	64	72	29.63	30.18	+.06	51.1	+1.2	75	25	61	24	11	42	31	45	41	75	4.20	+.5	8	5,744	s.	28	w.	18	13	5	13	5.1	.0	.0
Port Arthur	34	58	66	30.12	30.17	------	55.8	------	78	30	64	29	11	48	23	------	------	------	3.24	−2.0	9	5,786	s.	31	nw.	2	11	8	12	5.5	.0	.0
San Antonio	693	242	301	29.41	30.14	+.03	56.0	+2.3	75	25	64	33	8	48	26	51	47	76	4.17	+2.6	12	7,624	n.	44	nw.	18	9	7	15	6.0	.0	.0
Ohio Valley and Tennessee							35.8	−1.1										75	2.36	−1.2										7.1		
Chattanooga	762	71	214	29.35	30.19	+.03	42.4	−.9	65	25	50	15	12	35	28	37	30	67	3.18	−2.0	12	6,132	w.	38	w.	19	8	9	14	6.3	T	.0
Knoxville	995	66	84	29.09	30.18	+.02	39.4	−.9	60	25	47	15	12	32	28	35	30	74	2.72	−1.8	14	4,474	w.	29	w.	19	10	8	13	5.9	.3	.0
Memphis	399	78	86	29.74	30.17	+.02	42.6	−1.0	61	24	50	17	11	36	29	38	34	73	5.37	+.9	13	6,002	sw.	26	n.	26	9	8	14	6.0	T	.0
Nashville	546	168	191	29.59	30.19	+.04	39.9	−1.1	61	26	48	14	11	32	33	36	31	73	2.57	−1.6	12	7,174	nw.	30	nw.	26	6	9	16	7.0	.8	.0
Lexington	989	5	------	------	------	------	35.2	−.6	54	23	42	10	12	28	36	------	------	------	2.52	−1.2	13	------	se.	------	------	------	8	5	11	------	2.0	.0
Louisville	525	188	234	29.58	30.18	+.04	36.2	−1.4	54	26	43	10	11	29	36	32	27	73	2.37	−1.4	11	8,080	sw.	30	w.	26	9	6	16	6.5	2.0	.0
Evansville	431	76	116	29.68	30.17	+.04	36.0	−1.1	55	2	43	13	11	29	32	32	27	74	2.64	−.9	12	7,164	nw.	25	sw.	3	6	8	17	6.8	.6	.0
Indianapolis	822	194	230	29.23	30.15	+.03	30.2	−2.0	51	2	37	4	26	24	42	27	23	76	1.87	−1.1	12	8,608	w.	30	nw.	26	4	3	24	8.2	4.9	.0
Terre Haute	575	96	129	29.51	30.15	------	31.2	------	52	2	37	5	26	25	37	28	25	82	1.73	−1.2	10	7,274	nw.	25	sw.	3	6	6	19	7.3	9.2	.0
Cincinnati	627	11	51	29.45	30.16	+.03	33.4	.0	52	2	40	10	11	26	39	30	26	79	1.58	−1.4	10	6,444	sw.	27	sw.	19	4	8	19	7.6	3.4	.0
Columbus	822	216	230	29.23	30.14	+.02	31.6	−.8	50	2	38	9	12	25	29	28	25	79	1.30	−1.4	12	8,911	sw.	38	w.	26	3	7	21	7.6	3.0	.0
Elkins	1,947	59	78	28.03	30.18	+.06	30.9	−1.8	65	1	40	−5	11	22	41	27	23	77	2.11	−1.4	14	5,395	w.	30	w.	26	4	7	20	7.8	8.3	.0
Parkersburg	637	77	84	29.50	30.18	+.04	34.2	−1.0	56	1	42	12	12	26	38	30	27	78	1.72	−1.3	10	5,161	sw.	30	w.	26	5	4	22	7.6	.5	.0
Pittsburgh	842	353	410	29.19	30.12	+.01	32.9	−1.3	61	1	39	12	11	27	32	29	24	71	1.33	−1.5	15	8,345	w.	38	sw.	19	2	6	23	8.3	1.2	.0
Lower Lake Region							26.3	−2.8										79	2.07	−0.6										8.4		
Buffalo	768	243	280	29.20	30.06	.00	27.4	−2.4	54	1	34	7	11	21	28	25	22	82	2.89	−.5	23	12,503	w.	57	w.	26	1	6	24	8.5	9.8	.3
Canton	448	10	61	29.54	30.05	------	14.4	−8.3	58	1	24	−22	31	5	51	------	------	------	2.00	−.7	15	6,873	w.	38	w.	26	5	8	18	6.9	15.6	8.5
Ithaca	836	77	100	29.13	30.07	------	26.6	−2.4	64	1	34	3	31	19	29	24	20	77	1.61	−.8	15	8,065	nw.	34	w.	26	1	4	26	8.9	3.7	T
Oswego	335	71	85	29.68	30.06	.00	24.8	−4.2	65	1	32	−1	31	18	28	23	18	74	2.94	−.6	19	9,080	se.	41	w.	26	1	2	28	9.1	17.6	4.3
Rochester	523	86	102	29.48	30.07	+.01	26.8	−2.5	64	1	33	9	8	21	29	24	18	71	2.38	−.3	20	7,199	w.	31	w.	26	2	2	27	9.2	12.3	3.0
Syracuse	596	65	79	29.40	30.07	.00	26.0	−2.3	67	1	33	1	31	19	31	------	------	------	2.78	−.3	21	6,215	w.	31	nw.	26	1	4	26	8.8	10.9	3.0
Erie	714	130	166	29.28	30.08	+.01	29.8	−2.1	50	1	35	10	11	24	21	27	24	78	1.50	−1.3	19	10,753	sw.	38	se.	19	3	5	23	8.5	8.2	T
Cleveland	762	267	337	29.24	30.09	.00	31.0	−.2	55	1	37	10	27	26	28	28	24	78	1.84	−.6	17	10,942	w.	38	w.	13	2	7	22	8.5	20.4	.0
Sandusky	629	5	67	29.40	30.10	+.01	29.2	−2.0	47	1	35	1	27	23	31	------	------	------	1.23	−1.0	15	7,331	sw.	27	w.	26	0	8	23	8.5	6.2	.0
Toledo	628	79	87	29.41	30.12	+.04	27.4	−3.0	44	3	33	0	27	22	28	26	22	80	1.85	−.5	16	7,426	w.	32	nw.	26	3	6	22	7.9	17.4	.3
Fort Wayne	857	69	84	29.16	30.12	------	26.6	−.7	45	2	33	−2	27	20	35	25	23	85	1.40	−1.2	11	7,268	w.	28	w.	1	2	8	21	8.0	14.5	2.2
Detroit*	626	5	78	29.38	30.09	+.02	26.0	−3.3	46	1	32	2	27	20	26	24	22	85	2.43	+.1	12	7,966	sw.	33	sw.	1	3	8	20	7.9	12.2	1.3
Upper Lake Region							22.0	−2.4										83	1.70	−0.4										7.8		
Alpena	609	13	89	29.36	30.06	+.04	22.9	−1.9	43	1	29	2	26	17	27	22	18	79	1.48	−.6	18	8,869	nw.	35	nw.	26	2	5	24	8.4	16.8	4.8
Escanaba	612	54	60	29.38	30.07	+.04	21.1	−1.3	38	12	28	−6	26	15	32	20	17	82	1.36	−.4	14	7,814	nw.	28	n.	13	4	3	24	8.0	13.5	7.0
Grand Rapids	707	70	244	29.29	30.09	+.04	26.4	−2.1	39	3	32	5	27	21	26	24	21	79	1.51	−1.1	14	8,371	sw.	38	sw.	1	2	5	24	8.5	15.5	3.2
Lansing	878	6	88	29.10	30.08	------	23.8	−3.4	39	3	30	−2	27	17	31	24	22	93	1.78	−.3	17	7,498	sw.	27	nw.	26	3	5	23	8.1	16.8	5.0
Ludington	637	5	54	29.35	30.07	------	25.5	−2.9	38	15	30	6	10	21	19	24	------	------	1.77	−.7	13	------	se.	------	------	------	1	4	26	------	23.8	2.8
Marquette	734	77	111	29.22	30.05	+.03	21.8	−.8	40	12	27	−2	26	16	28	20	18	87	2.30	−.4	19	7,852	w.	30	s.	27	2	2	27	8.7	24.0	12.6

* Observations taken at airport.

TABLE 1.—*Climatological data for Weather Bureau stations, December 1934*—Continued

District and station	Elevation of instruments: Barometer above sea level	Elevation of instruments: Thermometer above ground	Elevation of instruments: Anemometer above ground	Pressure: Station, reduced to mean of 24 hours	Pressure: Sea level, reduced to mean of 24 hours	Pressure: Departure from normal	Temperature of air: Mean max. + mean min. ÷ 2	Temperature of air: Departure from normal	Temperature of air: Maximum	Temperature of air: Date	Temperature of air: Mean maximum	Temperature of air: Minimum	Temperature of air: Date	Temperature of air: Mean minimum	Temperature of air: Greatest daily range	Mean wet thermometer	Mean temperature of the dew point	Mean relative humidity	Precipitation: Total	Precipitation: Departure from normal	Precipitation: Days with .01, or more	Wind: Total movement	Wind: Prevailing direction	Wind: Maximum velocity: Miles per hour	Wind: Maximum velocity: Direction	Wind: Maximum velocity: Date	Clear days	Partly cloudy days	Cloudy days	Average cloudiness, tenths	Total snowfall	Snow, sleet, and ice on ground at end of month
Upper Lake Region—Continued	Ft.	Ft.	Ft.	In.	In.	In.	°F.	°F.	°F.		°F.	°F.		°F.	°F.	°F.	°F.	%	In.	In.		Miles								0-10	In.	In.
Sault Ste. Marie	614	11	52	29.34	30.07	+0.07	18.4	−2.1	41	1	25	−5	30	12	33	17	15	86	2.42	+0.1	23	6,971	se	30	nw.	26	7	4	20	7.5	31.4	10.1
Chicago	673	7	131	29.36	30.12	+.04	26.2	−2.6	42	3	32	−1	27	21	32	25	21	80	1.93	−.1	11	8,105	w.	32	sw.	3	7	2	22	7.6	27.4	4.5
Green Bay	617	109	141	29.39	30.08	+.04	20.4	−1.9	36	23	28	−12	26	13	39	19	15	80	.98	−.7	12	7,669	w.	30	w.	26	7	2	22	7.5	8.5	3.3
Milwaukee	681	97	221	29.33	30.10	+.04	24.4	−1.7	40	3	31	−5	26	18	33	22	18	74	1.22	−.5	10	10,251	w.	47	se.	3	5	8	18	7.6	8.1	1.4
Duluth	1,133	5	47	28.80	30.09	+.04	10.6	−5.3	38	12	19	−27	26	2	38	10	8	90	1.94	+.8	10	9,254	nw.	44	nw.	25	10	4	17	6.2	24.4	16.5
North Dakota							12.7	+0.3										87	0.34	−0.2										6.5		
Moorhead, Minn	940	50	58	29.08	30.15	+.07	11.0	−.5	44	12	19	−24	26	3	32	10	9	92	.40	−.3	9	6,771	n.	30	nw.	22	7	7	17	7.2	5.2	3.0
Bismarck	1,674	8	57	28.26	30.14	+.06	15.4	+.7	48	11	25	−22	26	6	35	14	10	80	.13	−.4	5	6,458	nw.	35	nw.	22	7	7	17	6.8	2.2	.1
Devils Lake	1,478	11	44	28.47	30.14	+.08	9.9	+.4	43	12	18	−33	26	1	33	8	7	93	.40	−.1	10	6,722	nw.	27	nw.	22	9	8	14	6.2	5.3	2.8
Grand Forks	833	12	67				9.0		38	12	17	−29	26	1	31	7			.53		9		nw.	35	nw.	22	12	3	16		5.7	5.2
Williston	1,878	41	48	28.06	30.14	+.08	14.5	+.7	45	11	24	−30	26	5	41	13	10	82	.43	−.2	10	5,942	s.	27	nw.	22	12	3	16	5.7	4.8	2.9
Upper Mississippi Valley							24.2	−2.9										83	1.34	−0.4										7.3		
Minneapolis	918	102	208	29.07	30.10		15.0	−4.6	42	12	22	−19	26	7	39	15	12	86	1.23	+.2	9	8,124	nw.	30	w.	23	6	8	17	7.1	13.0	7.5
La Crosse	714	11	48	29.31	30.12	+.04	17.6	−4.7	39	12	26	−13	26	10	36	17	14	85	1.12	−.2	11	4,372	s.	18	w.	22	4	8	19	7.5	9.0	6.6
Madison	974	70	78	29.01	30.12	+.04	20.2	−2.6	36	23	27	−8	26	14	30	19	18	85	.97	−.7	12	6,906	nw.	25	se.	22	6	5	20	7.3	7.3	3.6
Charles City	1,015	10	51	29.01	30.14	+.04	16.4	−4.0	37	22	25	−14	26	8	35	15	13	86	.84	−.5	8	5,950	nw.	21	nw.	22	7	3	21	7.5	8.9	6.7
Davenport	606	66	161	29.46	30.16	+.06	23.4	−3.7	41	15	30	−5	26	17	38	22	20	85	1.30	−.2	14	7,319	nw.	27	nw.	31	5	5	21	7.6	10.0	1.3
Des Moines	861	5	90	29.21	30.15	+.04	22.8	−3.2	43	15	30	−4	26	16	31	22	20	83	.30	−.9	8	7,432	nw.	27	nw.	22	4	5	22	8.0	3.4	.1
Dubuque	700	60	79	29.34	30.14	+.04	21.1	−3.6	39	15	28	−7	26	14	36	20	17	81	.99	−.4	12	5,041	nw.	23	nw.	26	5	7	19	7.4	7.3	.4
Keokuk	614	64	78	29.46	30.17	+.05	27.0	−2.6	47	15	34	−1	26	20	37	25	22	79	.91	−.5	11	6,175	nw.	28	sw.	3	5	4	22	7.7	6.5	T
Cairo	358	87	93	29.77	30.17	+.02	37.6	−.2	54	2	44	14	11	31	29	34	29	77	3.30	−.1	13	6,964	n.	25	sw.	3	7	7	17	6.6	1.5	.0
Peoria	609	11	45	29.46	30.16	+.05	26.0	−2.1	45	2	32	−3	26	20	36	24	22	85	1.34	−.4	12	5,824	nw.	24	sw.	3	7	6	18	7.2	8.2	2.1
Springfield, Ill	636	5	191	29.44	30.14	+.02	29.6	−2.1	51	2	36	2	26	23	29	27	25	84	1.88	−.3	12	8,633	nw.	32	nw.	31	7	4	20	7.5	9.4	.0
St. Louis	568	265	303	29.53	30.15	+.02	33.4	−1.3	51	2	40	10	26	27	33	30	26	78	1.95	−.3	11	8,882	s.	30	w.	19	9	4	18	6.6	8.8	.0
Missouri Valley							28.2	−0.6										81	0.60	−0.6										6.2		
Columbia, Mo	784	6	84	29.28	30.15	+.03	31.0	−2.2	56	15	38	5	11	24	32				1.19	−.7	10	6,503	nw.	27	sw.	3	8	5	18	6.6	8.0	.0
Kansas City *	750	32	45	29.32	30.16	+.04	31.1	−1.4	55	15	38	7	7	24	28	29	26	82	[illegible]	−.8	7	7,538	sw.	32	nw.	25	9	6	16	6.1	4.4	.0
St. Joseph	967	11	49	29.08	30.15		29.0		51	15	36	4	26	22	27	26	24	82	[illegible]	−.7	5	6,773	nw.	20	nw.	8	12	4	15	5.9	2.6	.0
Springfield, Mo	1,324	98	104	28.70	30.15	+.02	34.0	−2.2	59	15	42	8	11	27	25	31	28	81	[illegible]	−.8	9	8,225	se.	25	se.	2	12	6	13	5.0	5.0	.0
Iola	984	11	50	29.06	30.15	+.03	34.7	+.8	59	15	44	9	7	26	30				.85	−.5	5		n.				10	10	11		5.1	.0
Topeka	987	65	87				31.0	−1.0	56	15	38	3	7	24	27				.26	−.7	4	6,910	nw.	25	sw.	27	10	8	13	6.0	3.0	.0
Lincoln	1,189	11	81	28.84	30.16	+.04	26.5	−1.1	47	15	34	−2	7	19	36	24	21	80	.44	−.4	6	7,445	n.	27	nw.	31	9	9	13	6.0	4.9	.0
Omaha	1,105	170	200	28.93	30.17	+.06	25.3	−1.1	46	22	32	−2	26	18	32	23	20	79	.33	−.6	4	8,520	n.	32	n.	8	7	6	18	6.8	3.4	T
Valentine	2,598	47	54	27.34	30.16	+.06	26.0	+1.4	56	12	37	−9	26	14	47	22	18	77	.28	−.3	6	7,140	w.	30	nw.	22	11	9	11	5.5	3.0	T
Sioux City	1,138	64	106	28.88	30.15	+.03	22.2	−.9	48	22	30	−7	26	14	33	21	18	82	.63	−.3	3	7,789	nw.	31	nw.	22	4	9	18	7.5	7.3	T
Huron	1,306	60	74	28.76	30.16	+.06	20.0	+1.3	48	12	28	−14	26	12	42	18	15	83	.27	−.3	6	7,156	n.	24	nw.	22	10	5	16	6.4	2.3	T
Northern Slope							25.5	+1.6										74	0.58	−0.2										6.1		
Billings	3,140	4																														
Havre	2,505	11	67	27.39	30.14	+.09	23.1	+2.7	57	11	33	−19	25	13	48	18	15	79	.66	.0	8	7,186	sw.	31	sw.	31	6	11	14	6.4	7.3	2.6
Helena	4,124	85	111	25.82	30.18	+.05	22.6	−1.6	51	21	29	−14	25	16	47	20	15	72	.89	+.1	9	5,083	w.	38	w.	20	1	9	21	7.9	15.1	3.5
Kalispell	2,973	48	56	27.00	30.15	+.08	27.6	+2.7	46	21	32	2	25	23	24	26	23	82	.94	−.5	13	4,250	nw.	23	sw.	20	0	3	28	9.1	8.9	2.1
Miles City	2,371	48	55	27.52	30.18	+.08	22.5	+1.5	47	11	32	−11	25	14	34	20	17	82	.35	−.3	9	4,501	s.	24	nw.	22	8	8	15	6.3	5.2	2.2
Rapid City	3,259	50	58	26.61	30.15	+.06	29.0	+2.1	63	11	40	−11	26	18	63	24	18	67	.44	.0	6	6,318	w.	29	nw.	22	12	8	11	5.2	8.6	T
Cheyenne	6,094	50	71	23.98	30.12	+.03	31.0	+2.5	63	11	42	8	4	20	36	24	15	54	.15	−.4	7	9,911	nw.	39	w.	20	11	11	9	5.1	2.0	.0
Lander	5,372	60	68	24.66	30.22	+.07	22.2	+1.8	50	21	34	−5	5	10	30	19	16	80	.20	−.5	1	4,507	sw.	37	w.	20	13	11	7	4.1	3.3	2.0
Sheridan	3,790	10	47	26.10	30.12		28.7		56	21	41	−10	26	17	58	24	19	72	.68	.0	11	4,574	nw.	30	nw.	6	7	14	10	5.7	6.9	2.6
Yellowstone Park	6,241	11	48		30.23	+.07	23.0	+1.4	45	11	31	7	3	15	27			75	1.12	−.4	19	6,447	s.	32	sw.	26	4	4	23		21.2	6.7
North Platte	2,821	11	51	27.12	30.16	+.06	28.2	+1.5	58	22	30	1	26	18	37	24	21	81	.42	−.1	4	5,658	w.	28	w.	22	9	13	9	5.4	4.0	.0
Middle Slope							35.3	+1.8										68	0.47	−0.4										4.5		
Denver	5,292	106	113	24.73	30.10	+.02	36.0	+3.7	60	11	48	14	5	24	45	28	16	48	.67	−.1	4	5,787	s.	32	w.	20	12	14	5	4.1	7.0	.0
Pueblo	4,685	80	86	25.33	30.12	+.04	35.2	+3.7	69	11	50	10	26	20	50	28	18	55	.13	−.4	1	5,058	nw.	31	nw.	20	16	13	2	3.5	1.3	.0
Concordia	1,392	50	58	28.66	30.19	+.08	30.4	−.3	54	12	39	2	7	22	35	27	24	83	.22	−.4	3	6,221	n.	24	n.	9	11	9	11	5.3	.5	.0
Dodge City	2,509	10	86	27.49	30.18	+.08	35.4	+2.8	68	28	47	9	26	24	51	28	23	71	.13	−.4	4	8,564	n.	31	n.	31	14	11	6	3.8	.2	.0
Wichita	1,358	85	93	28.67	30.15	+.04	34.2	−.4	57	15	43	7	26	26	33	31	27	76	1.03	.0	1	7,934	n.	35	sw.	22	13	6	12	5.1	3.0	.0
Oklahoma City	1,214	10	47	28.84	30.16	+.05	40.6	+1.3	66	28	50	17	7	31	36	35	31	75	.62	−.9	3	7,658	s.	27	nw.	7	12	8	11	5.2	T	.0
Southern Slope							47.2	+3.1										60	0.36	−0.5										4.9		
Abilene	1,738	10	52	28.31	30.16	+.05	48.4	+2.4	73	25	59	26	7	37	33	41	33	61	.39	−1.0	3	6,555	s.	31	w.	18	11	7	13	5.5	.0	.0
Amarillo	3,676	10	49	26.33	30.13	+.04	42.0	+5.0	67	28	54	19	26	30	40	33	24	55	.40	−.4	1	6,541	sw.	27	n.	18	14	10	7	4.2	3.0	.0
Big Spring	2,537	5	62	27.49	30.16		47.0		76	29	59	24	4	35	37	38	31	63	.08		3		s.				13	5	13	5.4	.0	.0
Del Rio	944	64	71	29.11	30.12	+.02	54.8	+2.6	76	30	65	32	20	45	37	48	41	66	.61	−.1	8	5,550	se.	38	nw.	18	11	6	14	5.7	.0	.0
Roswell	3,566	75	85	26.46	30.14	+.07	43.6	+2.4	71	28	57	20	3	30	41	35	25	53	.05	−.6	1	5,084	n.	37	nw.	18	17	6	8	3.9	.0	.0
Southern Plateau							44.9	+3.2										59	0.80	+0.1										3.9		
El Paso	3,778	152	175	26.28	30.12	+.09	48.5	+3.6	70	12	60	24	3	37	34	39	28	50	.32	−.2	3	5,706	nw.	28	nw.	29	17	7	7	3.7	T	.0
Albuquerque	4,972	5	39	25.15	30.19		36.0		57	16	49	12	4	23	37	28	22	66	.78	+.3	4	4,830	n.	34	w.	17	13	12	6	4.5	.0	.0
Santa Fe	7,013	38	53	23.29	30.19	+.13	32.5	+1.8	57	12	42	7	2	23	33	27	22	69	.80	+.1	5	4,383	n.	21	n.	20	16	8	7	4.0	5.5	T
Flagstaff	6,907	10	59	23.38	30.10	+.04	32.5	+4.1	57	20	45	6	3	20	39	26		67	1.27		7	5,654	se.	24	nw.	19	11	14	6		T	.0
Phoenix	1,108	10	107	28.90	30.07	+.03	56.0	+4.0	81	11	68	30	3	44	40	46	36	55	1.71	+.7	3	3,615	e.	18	n.	2	17	5	9	3.9	.0	.0
Yuma	141	9	54	29.92	30.08	+.03	57.8	+2.6	77	11	69	35	30	47	33	47	36	48	.65	+.1	3	4,441	n.	21	n.	18	18	6	7	3.4	.0	.0
Independence	3,957	5	26	26.08	30.18	+.06	42.2	+2.9	65	9	54	17	29	30	32	33			.54	−.2	1		n.				15	8	8		.0	.0

* Observations taken at airport.

TABLE 1.—*Climatological data for Weather Bureau Stations, December 1934*—Continued

District and station	Elevation of instruments: Barometer above sea level	Elevation of instruments: Thermometer above ground	Elevation of instruments: Anemometer above ground	Pressure: Station, reduced to mean of 24 hours	Pressure: Sea level, reduced to mean of 24 hours	Pressure: Departure from normal	Temperature of air: Mean max. + mean min. ÷ 2	Temperature of air: Departure from normal	Temperature of air: Maximum	Temperature of air: Date	Temperature of air: Mean maximum	Temperature of air: Minimum	Temperature of air: Date	Temperature of air: Mean minimum	Temperature of air: Greatest daily range	Mean wet thermometer	Mean temperature of the dew point	Mean relative humidity	Precipitation: Total	Precipitation: Departure from normal	Precipitation: Days with .01, or more	Wind: Total movement	Wind: Prevailing direction	Wind: Maximum velocity: Miles per hour	Wind: Maximum velocity: Direction	Wind: Maximum velocity: Date	Clear days	Partly cloudy days	Cloudy days	Average cloudiness, tenths	Total snowfall	Snow, sleet, and ice on ground at end of month
	Ft.	Ft.	Ft.	In.	In.	In.	°F.	°F.	°F.		°F.	°F.		°F.	°F.	°F.	°F.	%	In.	In.		Miles								0-10	In.	In.
Middle Plateau							**33.1**	**+2.9**										70	**0.97**	**0.0**										**5.1**		
Reno	4,527	61	76	25.50	30.24	+0.09	35.3	+1.6	60	21	46	15	3	24	32	31	25	66	0.27	−0.7	3	3,915	w.	32	sw.	26	14	12	5	4.0	1.1	T
Tonopah	6,090	12	20	------			34.3	------	55	12	42	14	2	27	22	29	23	64	.90	------	4	------	se.	------	------	------	------	------	------	------	------	------
Winnemucca	4,344	18	56	25.75	30.25	+.07	33.0	+3.0	57	21	43	8	2	24	31	29	26	78	1.06	.0	5	6,288	ne.	27	s.	29	10	11	10	5.2	1.5	0.0
Modena	5,473	10	46	24.71	30.19	+.07	31.0	+2.9	55	21	42	4	3	20	37	26	22	74	1.08	+.2	4	6,238	sw.	35	sw.	27	10	11	10	5.5	.1	.0
Salt Lake City	4,360	86	210	25.77	30.25	+.10	33.2	+1.3	52	21	40	14	2	27	21	29	24	69	1.87	+.4	8	4,375	s.	30	n.	22	9	6	16	6.0	15.9	1.5
Grand Junction	4,602	60	68	25.50	30.18	+.08	33.2	+5.7	52	27	43	17	4	24	32	28	23	70	.58	.0	5	3,824	se.	18	sw.	27	12	10	9	4.6	.4	.0
Northern Plateau							**33.0**	**+2.4**										78	**1.24**	**−0.4**										**8.0**		
Baker	3,471	48	53	26.57	30.26	+.10	28.2	+.9	48	20	36	9	6	21	23	26	22	78	1.01	−.7	11	4,796	se.	26	sw.	21	5	7	19	7.1	11.4	2.6
Boise	2,739	79	87	27.36	30.30	+.10	32.9	+.8	53	21	38	20	11	28	20	30	26	77	1.49	−.1	15	4,017	se.	30	nw.	21	0	6	25	8.8	4.7	1.2
Pocatello	4,477	60	68	25.59	30.25	+.06	29.3	+1.6	47	21	35	10	7	23	24	27	23	75	1.30	+.1	14	8,049	se.	37	sw.	20	5	8	18	6.9	13.9	4.5
Spokane	1,929	101	110	28.06	30.17	+.09	32.9	+2.4	50	21	37	22	25	29	16	31	29	84	1.50	−.7	16	5,150	s.	26	sw.	20	1	5	25	8.6	7.9	2.7
Walla Walla	991	57	65	29.10	30.19	+.07	39.3	+3.8	60	21	45	27	5	34	21	36	32	75	1.57	−.5	10	5,004	s.	27	w.	29	1	5	25	8.8	T	.0
Yakima	1,076	58	67	29.01	30.19	------	35.4	+4.7	54	20	41	23	31	30	21	33	29	76	.59	−.8	9	3,626	nw.	27	w.	24	5	6	20	7.5	1.1	.0
North Pacific Coast Region							**44.8**	**+2.3**										84	**7.86**	**+0.6**										**8.0**		
North Head	211	11	56	29.86	30.10	+.07	46.2	+2.1	61	6	50	34	27	42	19	44	40	81	8.94	−.5	24	12,524	e.	65	s.	25	5	4	22	7.6	T	.0
Seattle	125	90	321	29.95	30.08	+.07	44.0	+2.3	55	19	48	33	9	40	20	42	39	82	5.46	−.1	22	8,551	s.	45	sw.	25	1	6	24	8.5	.4	.0
Tatoosh Island	86	10	54	29.93	30.03	+.07	45.2	+1.3	53	3	48	34	27	42	13	44	42	90	14.38	+1.0	24	14,306	e.	71	sw.	26	5	5	21	7.7	4.9	.0
Medford	1,329	29	58	28.77	30.22	------	40.2	------	63	7	48	24	9	33	33	38	36	84	2.18	−.9	13	3,263	nw.	21	nw.	21	4	7	20	7.5	T	.0
Portland, Oreg	153	68	106	30.00	30.16	+.09	44.1	+2.9	57	20	48	34	30	40	11	41	38	80	10.83	+4.1	23	6,150	s.	23	e.	7	3	3	25	8.1	T	.0
Roseburg	510	45	76	29.64	30.20	+.09	44.6	+2.8	61	15	50	33	31	39	19	42	40	86	5.39	.0	19	3,008	sw.	19	w.	26	1	4	26	8.7	.0	.0
Middle Pacific Coast Region							**50.0**	**+1.4**										76	**3.95**	**−0.5**										**5.6**		
Eureka	62	73	80	30.14	30.21	+.09	49.2	+1.0	67	5	56	36	2	42	28	46	44	85	5.28	−1.0	15	4,438	se.	26	se.	16	9	8	14	5.9	.0	.0
Redding	722	20	34	------	------	------	48.6	------	72	9	56	28	25	41	25	42	35	66	3.42	------	8	5,447	nw.	25	n.	5	9	8	14	6.3	.0	.0
Sacramento	69	92	115	30.10	30.18	+.04	47.8	+1.6	68	6	55	34	31	40	30	45	41	80	2.50	−.5	8	5,415	se.	25	nw.	4	11	8	12	5.4	.0	.0
San Francisco	155	208	243	29.99	30.16	+.04	52.9	+1.6	69	7	58	42	25	48	18	48	42	71	4.06	+.1	8	4,590	n.	30	ne.	5	14	9	8	4.9	.0	.0
South Pacific Coast Region							**55.8**	**+2.9**										70	**3.01**	**+1.0**										**5.3**		
Fresno	327	97	105	29.82	30.19	+.06	47.5	+1.3	67	11	55	32	5	40	27	45	42	83	1.89	+.4	7	3,512	nw.	17	se.	8	7	10	14	6.5	.0	.0
Los Angeles	338	159	191	29.71	30.07	.00	60.8	+4.2	79	21	69	44	30	53	25	50	41	56	3.75	+1.1	8	4,478	ne.	19	ne.	12	17	3	11	4.0	.0	.0
San Diego	87	62	70	29.96	30.05	−.02	59.1	+3.1	78	10	66	44	3	52	22	53	48	71	3.38	+1.5	8	4,148	nw.	21	se.	6	12	6	13	5.3	.0	.0
West Indies																																
San Juan, P. R	82	9	54	29.93	30.02	------	76.6	+.3	87	8	82	67	31	72	18	------	------	------	9.53	+4.0	26	10,493	e.	40	ne.	3	1	22	8	6.2	.0	.0
Panama Canal																																
Balboa Heights	118	6	97	------	[1] 29.82	.00	80.2	+.2	91	3	87	71	1	73	18	------	------	[1] 85	2.71	−1.6	16	3,856	nw.	21	nw.	14	2	21	8	6.2	.0	.0
Cristobal	36	6	97	------	[1] 29.84	.00	80.8	+.9	88	7	85	73	13	76	14	76	75	[1] 84	15.66	+4.6	23	7,379	n.	34	nw.	14	6	9	16	6.8	.0	.0
Alaska																																
Fairbanks	454	11	87	29.40	29.97	------	1.6	------	58	5	9	−40	31	−6	38	1	−3	77	.30	------	8	3,891	n.e.	25	e.	8	14	3	14	5.2	7.2	3.0
Juneau	80	96	116	[2] 29.81	[2] 29.90	------	29.4	------	59	8	33	2	23	26	14	27	20	69	4.38	------	21	6,681	s.	32	ne.	23	7	1	23	7.6	7.9	2.0
Hawaiian Islands																																
Honolulu	38	86	100	[2] 29.96	[2] 30.00	------	74.9	+2.5	83	16	80	66	23	70	13	69	67	78	2.48	−1.5	14	6,466	e.	27	e.	26	14	14	3	4.1	.0	.0

* Observations taken at airport. [1] Observations taken bihourly. [2] Pressure not reduced to mean of 24 hours.

TABLE 2.—*Data furnished by the Canadian Meteorological Service, December 1934*

Stations	Altitude above mean sea level, Jan. 1, 1919	Pressure: Station reduced to mean of 24 hours	Pressure: Sea level reduced to mean of 24 hours	Pressure: Departure from normal	Temperature of the air: Mean max. + mean min. ÷ 2	Temperature of the air: Departure from normal	Temperature of the air: Mean maximum	Temperature of the air: Mean minimum	Temperature of the air: Highest	Temperature of the air: Lowest	Precipitation: Total	Precipitation: Departure from normal	Precipitation: Total snowfall
	Feet	*In.*	*In.*	*In.*	°*F.*	°*F.*	°*F.*	°*F.*	°*F.*	°*F.*	*In.*	*In.*	*In.*
Cape Race, Newfoundland	99												
Sydney, Cape Breton Island	48												
Halifax, Nova Scotia	88												
Yarmouth, Nova Scotia	65												
Charlottetown, Prince Edward Island	38												
Chatham, New Brunswick	28												
Father Point, Quebec	20												
Quebec, Quebec	296												
Doucet, Quebec	1,236				0.7		12.2	−10.8	40	−36	3.09		24.9
Montreal, Quebec	187												
Ottawa, Ontario	236	29.77	30.06	+0.04	14.4	−2.6	22.0	6.8	47	−15	3.02	+0.11	24.2
Kingston, Ontario	285												
Toronto, Ontario	379	29.64	30.07	+.02	25.6	−1.4	31.8	19.3	45	0	2.60	−.31	17.0
Cochrane, Ontario	930				2.7		11.3	−5.9	36	−29	2.28		22.6
White River, Ontario	1,244	28.66	30.06	+.09	2.1	−7.6	16.0	−11.8	32	−42	2.21	+.50	22.1
London, Ontario	808				22.7		29.9	15.5	43	−8	3.29		22.4
Southampton, Ontario	656	29.30	30.04	+.02	23.4	−3.3	29.4	17.4	41	0	2.74	−1.24	24.8
Parry Sound, Ontario	688	29.32	30.05	+.04	16.7	−4.5	24.0	9.5	44	−12	3.00	−1.48	23.9
Port Arthur, Ontario	644	29.34	30.08	+.09	13.2	.0	21.8	4.7	30	−20	1.10	+.23	11.0
Winnipeg, Manitoba	760	29.26	30.15	+.13	5.0	+.9	13.3	−3.2	35	−37	.94	+.03	9.4
Minnedosa, Manitoba	1,690	28.20	30.13	+.11	5.7	.0	14.0	−2.5	33	−38	.36	−.26	3.6
Le Pas, Manitoba	860		30.15		−.6		8.2	−9.4	34	−42	.31		3.1
Qu'Appelle, Saskatchewan	2,115	27.69	30.06	+.06	7.9	+.5	16.1	−.3	36	−36	.48	−.04	4.8
Moose Jaw, Saskatchewan	1,759												
Swift Current, Saskatchewan	2,392	27.42	30.08	+.09	13.8	−2.2	22.5	5.1	44	−30	.50	−.28	5.0
Medicine Hat, Alberta	2,365	27.45	30.04	+.07	16.2	−2.0	24.9	7.5	45	−31	.85	+.30	8.3
Calgary, Alberta	3,540												
Banff, Alberta	4,521												
Prince Albert, Saskatchewan	1,450	28.51	30.19	+.18	3.8	+1.0	11.1	−3.4	40	−46	.91	+.17	9.1
Battleford, Saskatchewan	1,592	28.29	30.14	+.15	4.2	−1.2	12.6	−4.2	37	−43	1.62	+1.30	16.2
Edmonton, Alberta	2,150												
Kamloops, British Columbia	1,262												
Victoria, British Columbia	230	29.80	30.06	+.09	42.2	+1.0	45.8	38.7	52	30	6.42	−1.56	.4
Barkerville, British Columbia	4,180												
Estevan Point, British Columbia	20												
Prince Rupert, British Columbia	170												
Hamilton, Bermuda	151												

LATE REPORTS NOVEMBER 1934

Stations	Altitude above mean sea level, Jan. 1, 1919	Pressure: Station reduced to mean of 24 hours	Pressure: Sea level reduced to mean of 24 hours	Pressure: Departure from normal	Temperature of the air: Mean max. + mean min. ÷ 2	Temperature of the air: Departure from normal	Temperature of the air: Mean maximum	Temperature of the air: Mean minimum	Temperature of the air: Highest	Temperature of the air: Lowest	Precipitation: Total	Precipitation: Departure from normal	Precipitation: Total snowfall
Banff, Alberta	4,521	25.25	29.89	−0.07	32.4	+6.6	39.4	25.4	53	8	0.57	−1.70	2.4
Estevan Point, British Columbia	20				47.9		51.9	43.9	61	36	18.07		.0
Prince Rupert, British Columbia	170				43.3		48.1	38.5	59	32	9.20		.0

SEVERE LOCAL STORMS, DECEMBER 1934

(Compiled by Mary O. Souder)

[The table herewith contains such data as have been received concerning severe local storms that occurred during the month. A revised list of tornadoes will appear in the Annual Report of the Chief of Bureau]

Place	Date	Time	Width of path (yards)	Loss of life	Value of property destroyed	Character of storm	Remarks	Authority
Harrisburg, Pa.	Nov. 30-Dec. 1					Excessive rain	3.19 inches of rain fell during this storm breaking all records for the maximum 24-hour fall for December; fields, highways, farm buildings, and some rural dwellings in the lowlands flooded; traffic suspended on the highways because of high water covering the roadways to a depth of several feet.	Official U. S. Weather Bureau.
Muskegon Harbor (near), Mich.	1	a. m.		1		Wind	A freighter driven against the breakwater sank near Muskegon Harbor; cargo lost; member of the Coast Guard drowned.	Do.
Hope Valley, R. I.	1	3 p. m.			$4,500	do	A sudden gust of wind lifted a large barn from its foundation, twisted it around and returned it to its foundation without toppling it over; the barn was under construction and almost completed.	Do.
Lincoln, Nebr.	2					Sleet and snow	Sleet followed by snow caused the streets to become unusually slippery, this condition lasting a week; many accidents to pedestrians and motorists.	Do.
Minneapolis, Minn.	2-3					Snow	7.4 inches of snow recorded; this with the heavy snowfall of Nov. 30 caused the difficulties of traffic to be materially increased.	Do.
Duluth, Minn.	3					do	Snowfall of 16.8 inches, the greatest of record for December, recorded during this storm; traffic paralyzed in the afternoon.	Do.
Cleveland, Ohio	8-9					do	9.1 inches of snow fell from 6 a. m., of the 8th to 6 a. m., of the 9th, heaviest 24-hour fall of record for December.	Do.
Chicago, Ill.	10	Noon to 7 p. m.				do	Snow was very heavy in a belt about 40 miles long and a few miles wide lying along and near the shore of Lake Michigan. This belt extended from about 10 miles north of the northern boundary of the city to about the same distance beyond the southern and southeastern boundaries; snow driven by strong northwest winds lowered the visibility to less than 100 feet in the late afternoon; total depth for the day 10.9 inches; traffic badly hampered.	Do.
Milwaukee, Wis.	15	9 a. m. to 1 p. m.				Glaze	An inch coating of smooth glaze remained for 2 days; many traffic accidents reported.	Do.
Grand Rapids, Mich.	15-16					Rain and sleet	Rain froze on the ground making driving hazardous; many accidents reported; several persons injured.	Do.
Helena, Mont.	20	12:14 p. m.			500	Wind	Property damaged	Do.
Springfield, Ill.	24					Sleet	Rain froze as it fell making streets and walks slippery and hazardous for travel.	Do.
Detroit, Mich.	26	1 p. m.				Snow	Due to sub-freezing temperatures, the snow remained on the ground; streets and sidewalks slippery and hazardous for automobiles and pedestrians.	Do.
Greensboro, N. C.	31					Glaze	Glaze heavy on wires and trees	Do.
LATE REPORTS FOR NOVEMBER 1934								
Little River County, Ark., northwest into McCurtain County, Okla.	20		150	0	$12,000	Tornado	3 persons injured; property damaged over a path 5 miles long.	Do.
Virginia	29-30				260,000	Heavy rain	Account of this storm published in November, but amount of damage not reported at that time.	Do.

O

Chart I. Departure (°F.) of the Mean Temperature from the Normal, December 1934

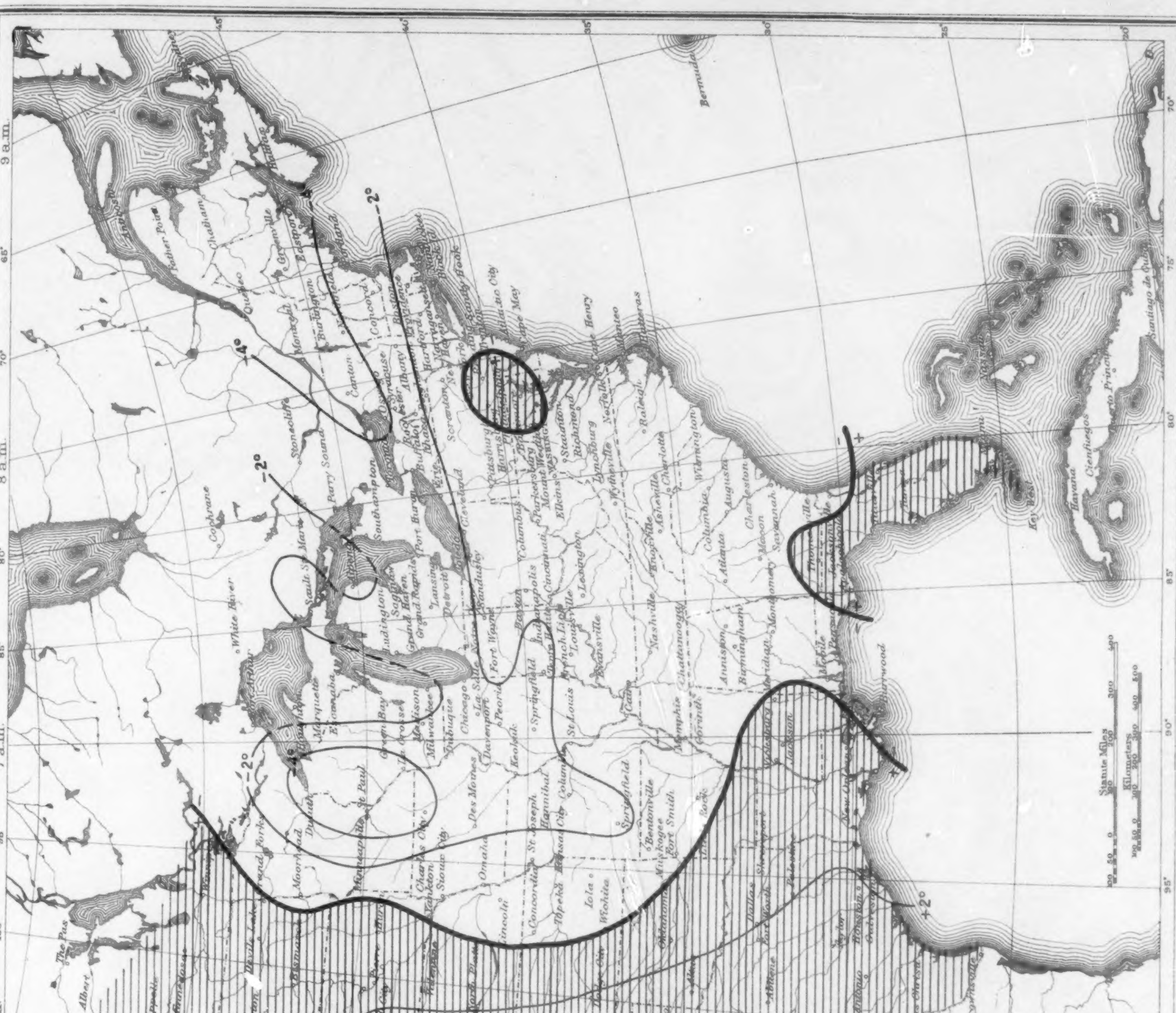
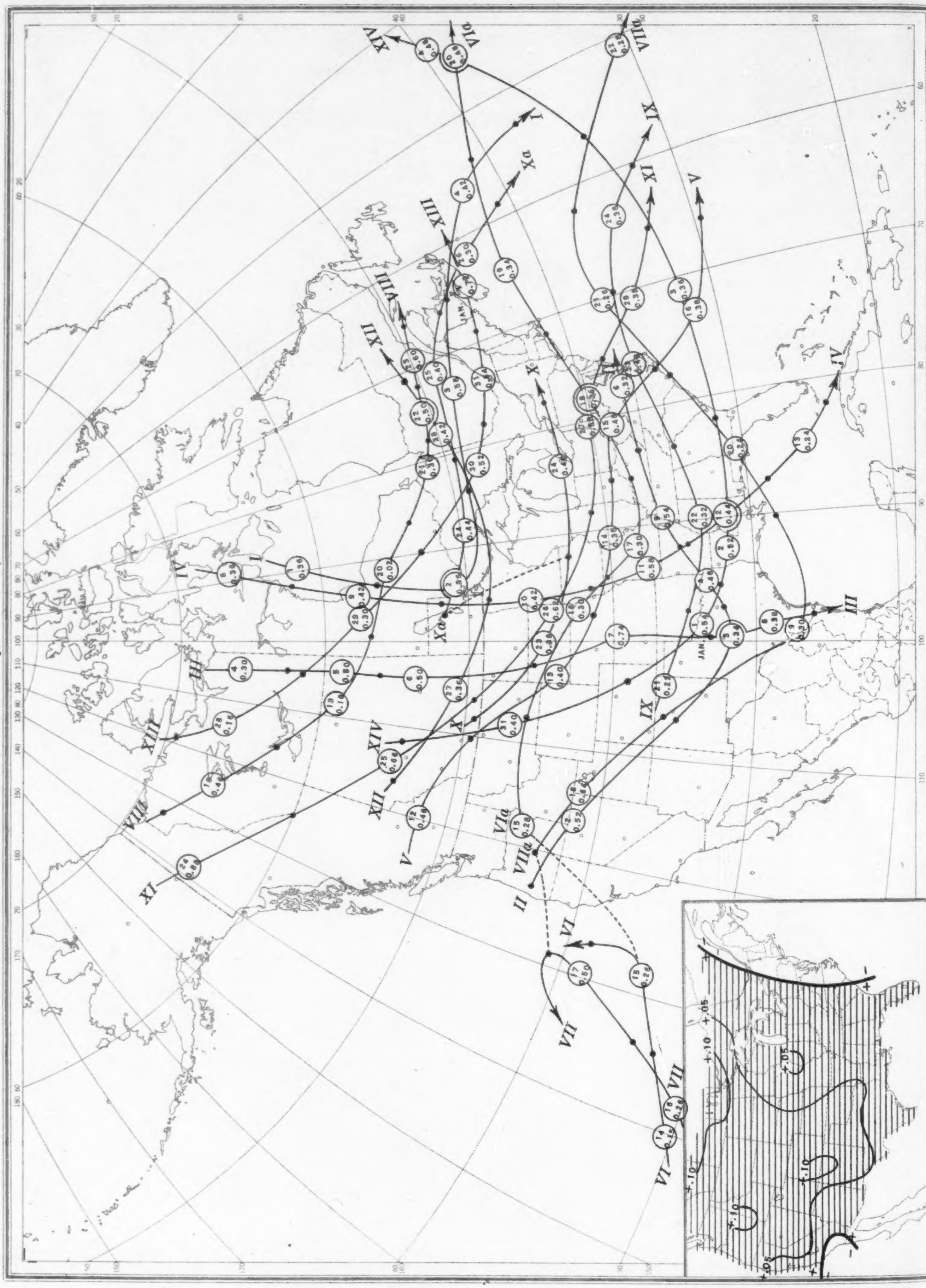


Chart II. Tracks of Centers of Anticyclones, December 1934. (Inset) Departure of Monthly Mean Pressure from Normal

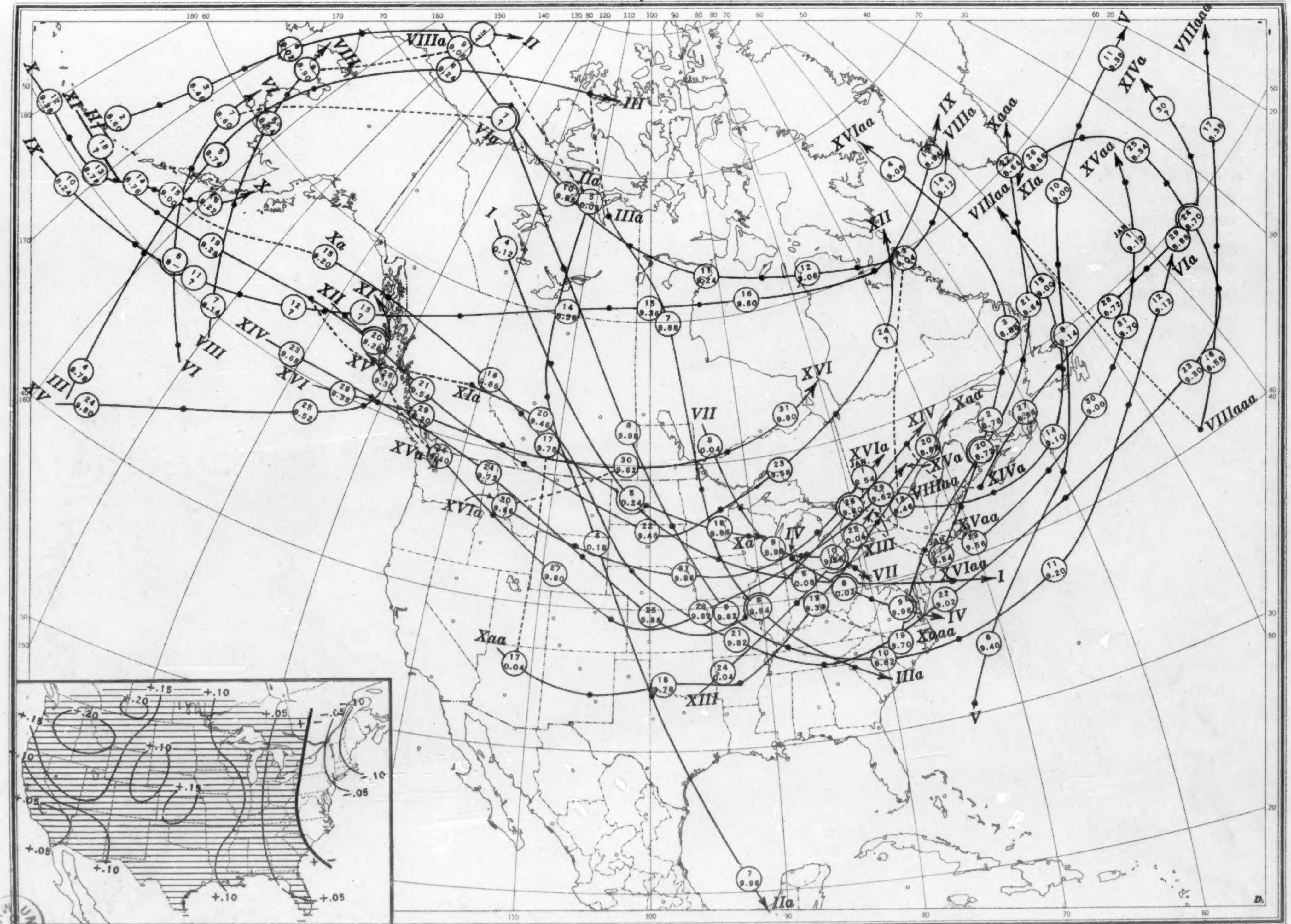
(Plotted by G. E. Dunn)



Circle indicates position of anticyclone at 8 a. m. (75th meridian time), with barometric reading. Dot indicates position of anticyclone at 8 p. m. (75th meridian time).

Chart III. Tracks of Centers of Cyclones, December 1934. (Inset) Change in Mean Pressure from Preceding Month

(Plotted by G. E. Dunn)



Circle indicates position of cyclone at 8 a. m. (75th meridian time), with barometric reading. Dot indicates position of cyclone at 8 p. m. (75th meridian time).

Chart IV. Percentage of Clear Sky Between Sunrise and Sunset, December 1934

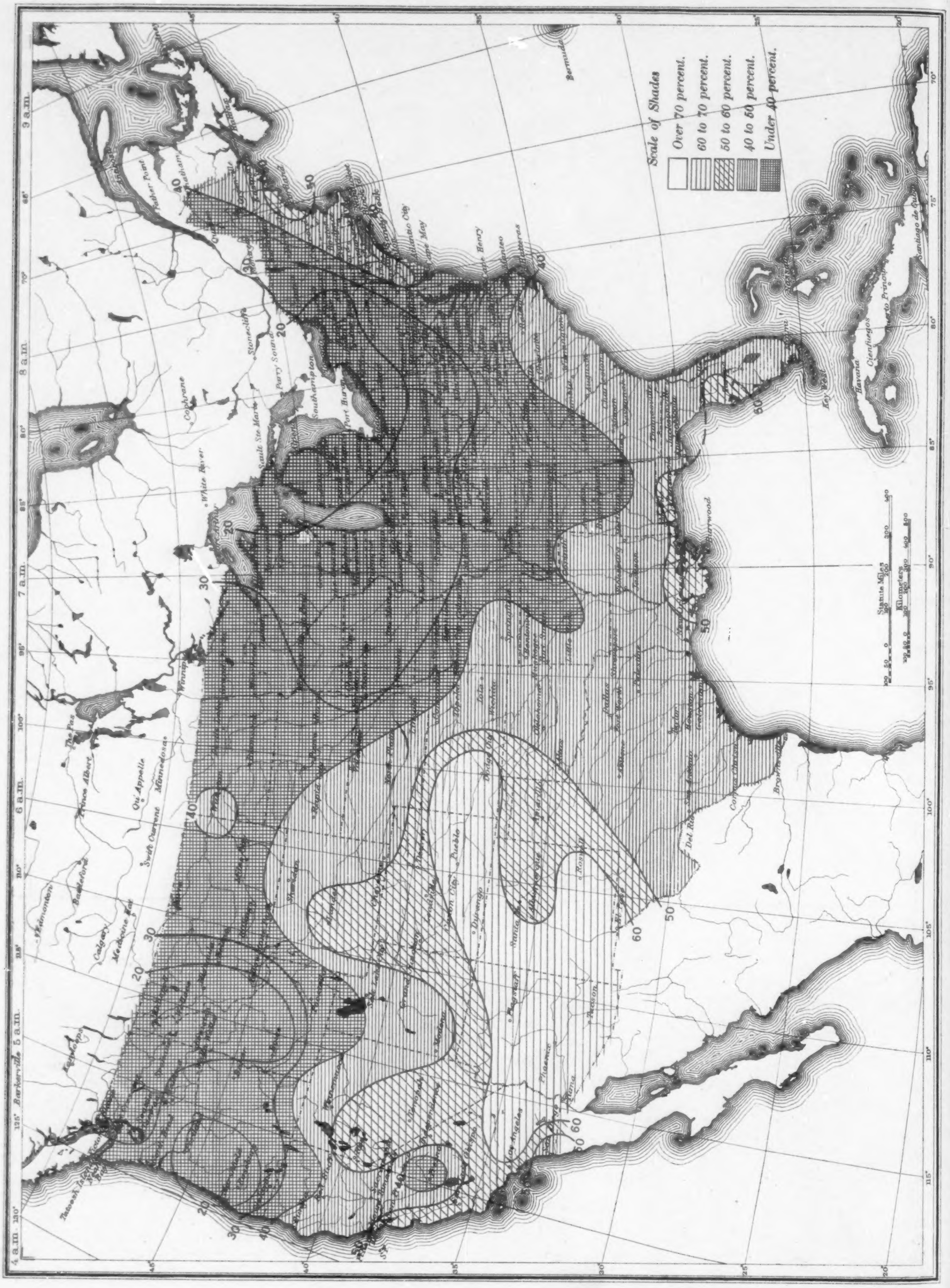


Chart V. Total Precipitation, Inches, December 1934. (Inset) Departure of Precipitation from Normal

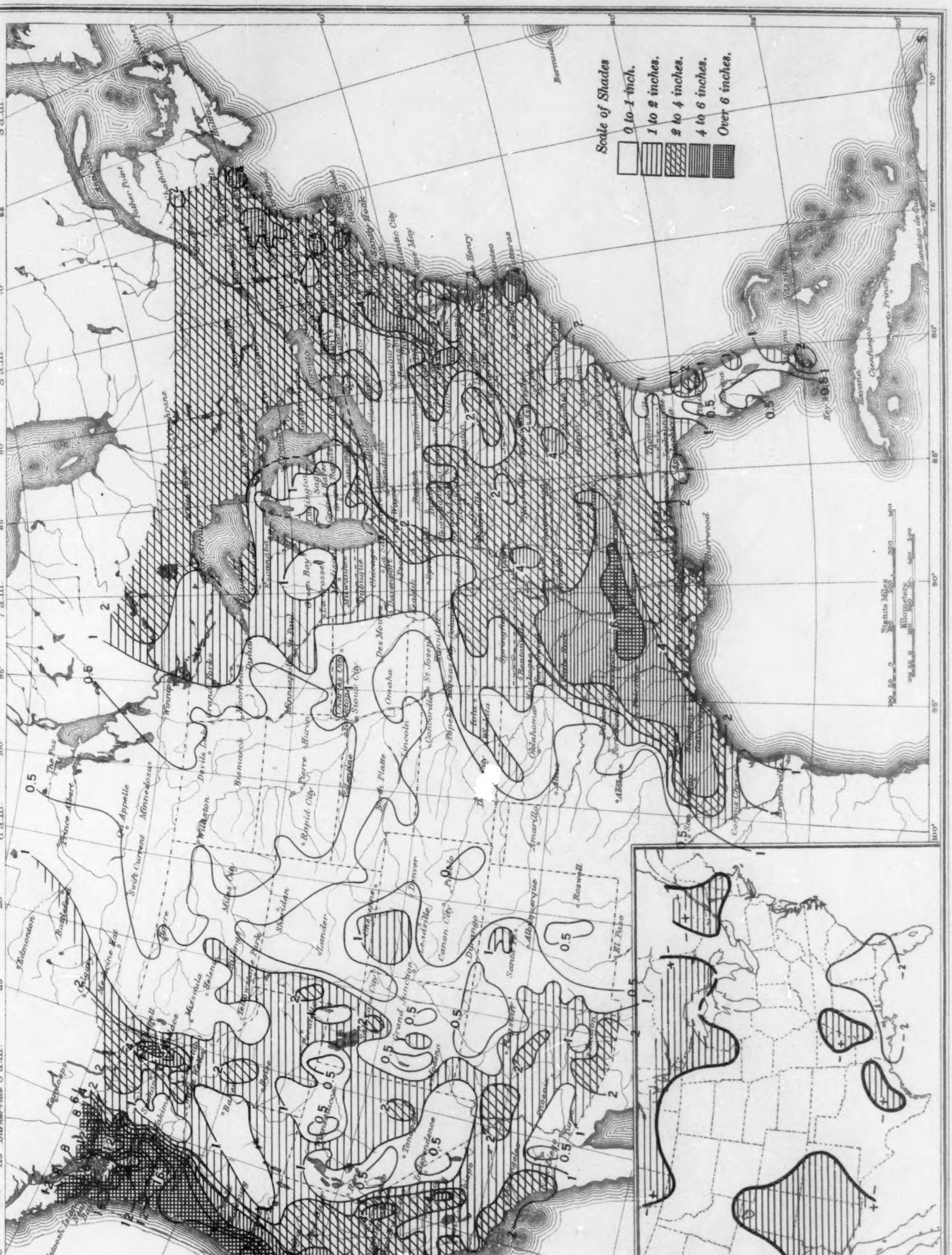


Chart VI. Isobars at Sea Level and Isotherms at Surface; Prevailing Winds, December 1934

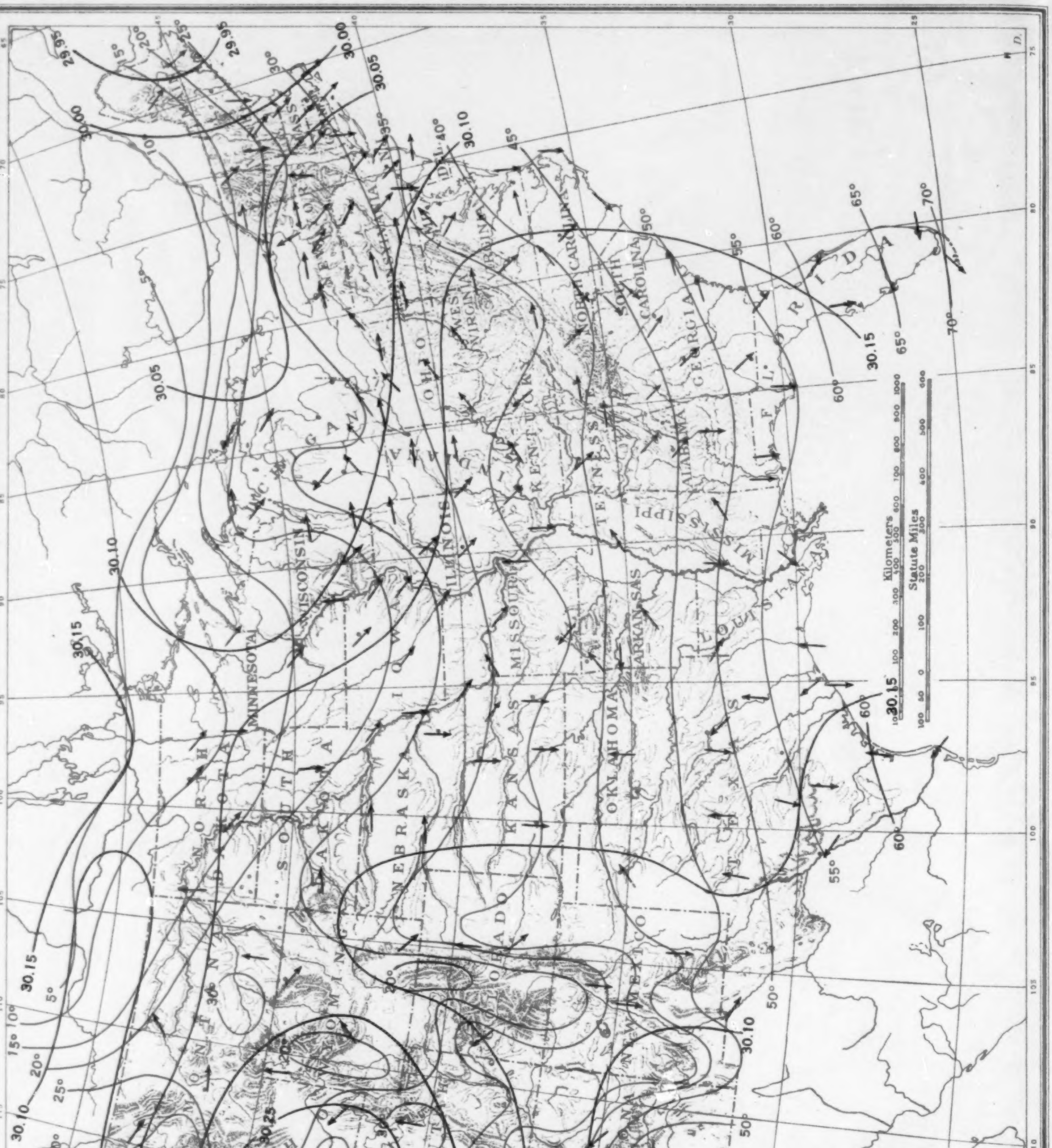
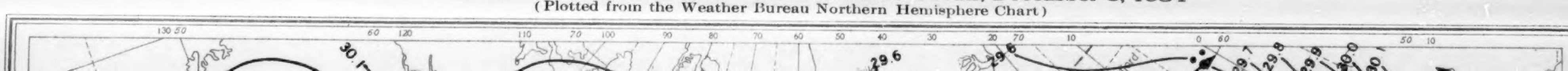


Chart VII. Total Snowfall, Inches, December 1934. (Inset) Depth of Snow on Ground at 8 p. m., Monday, December 31, 1934

Chart VIII. Weather Map of North Atlantic Ocean, December 8, 1934
(Plotted from the Weather Bureau Northern Hemisphere Chart)



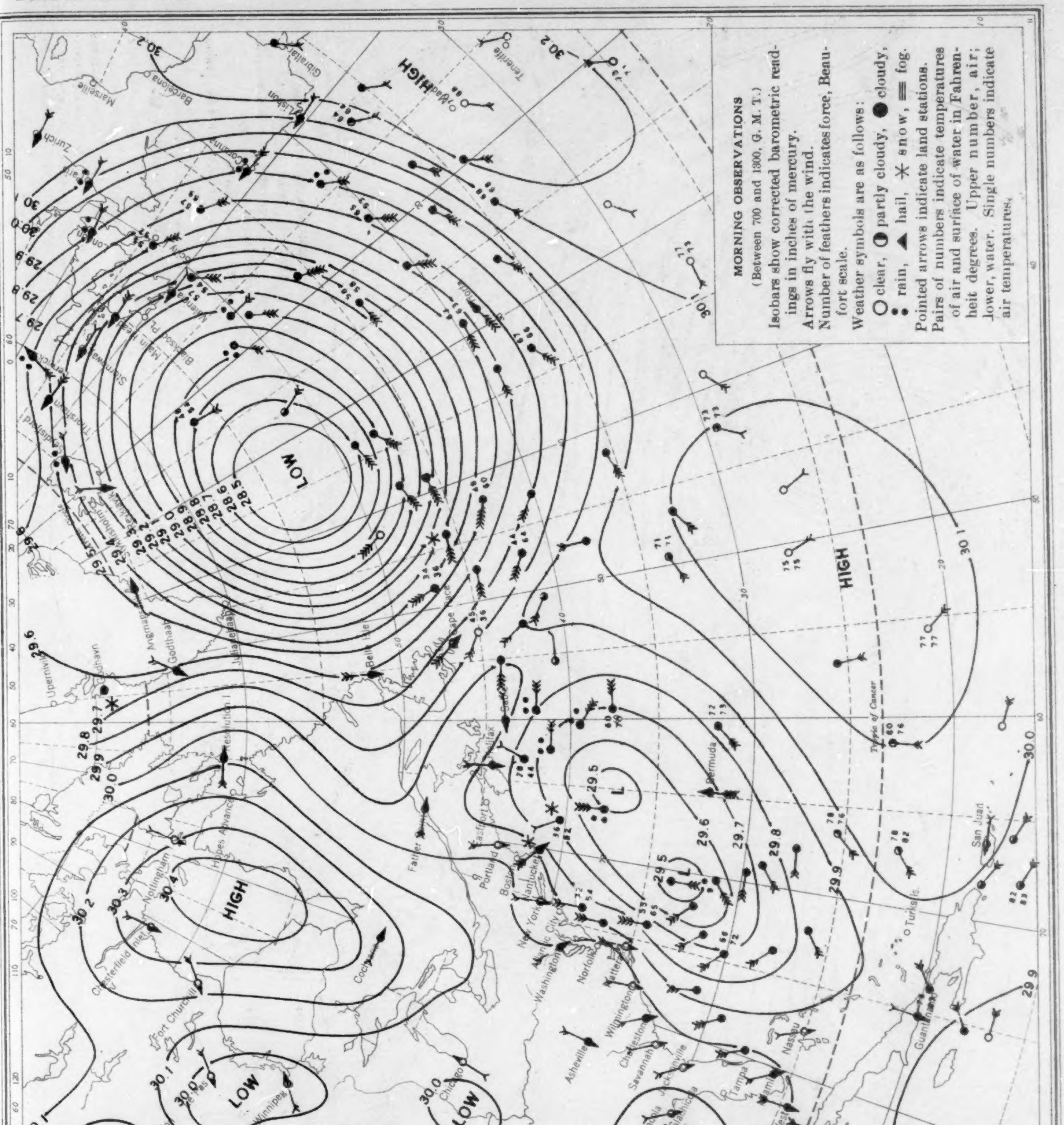


Chart VIII. Weather Map of North Atlantic Ocean, December 8, 1934
(Plotted from the Weather Bureau Northern Hemisphere Chart)

Chart IX. Weather Map of North Atlantic Ocean, December 11, 1934
(Plotted from the Weather Bureau Northern Hemisphere Chart)

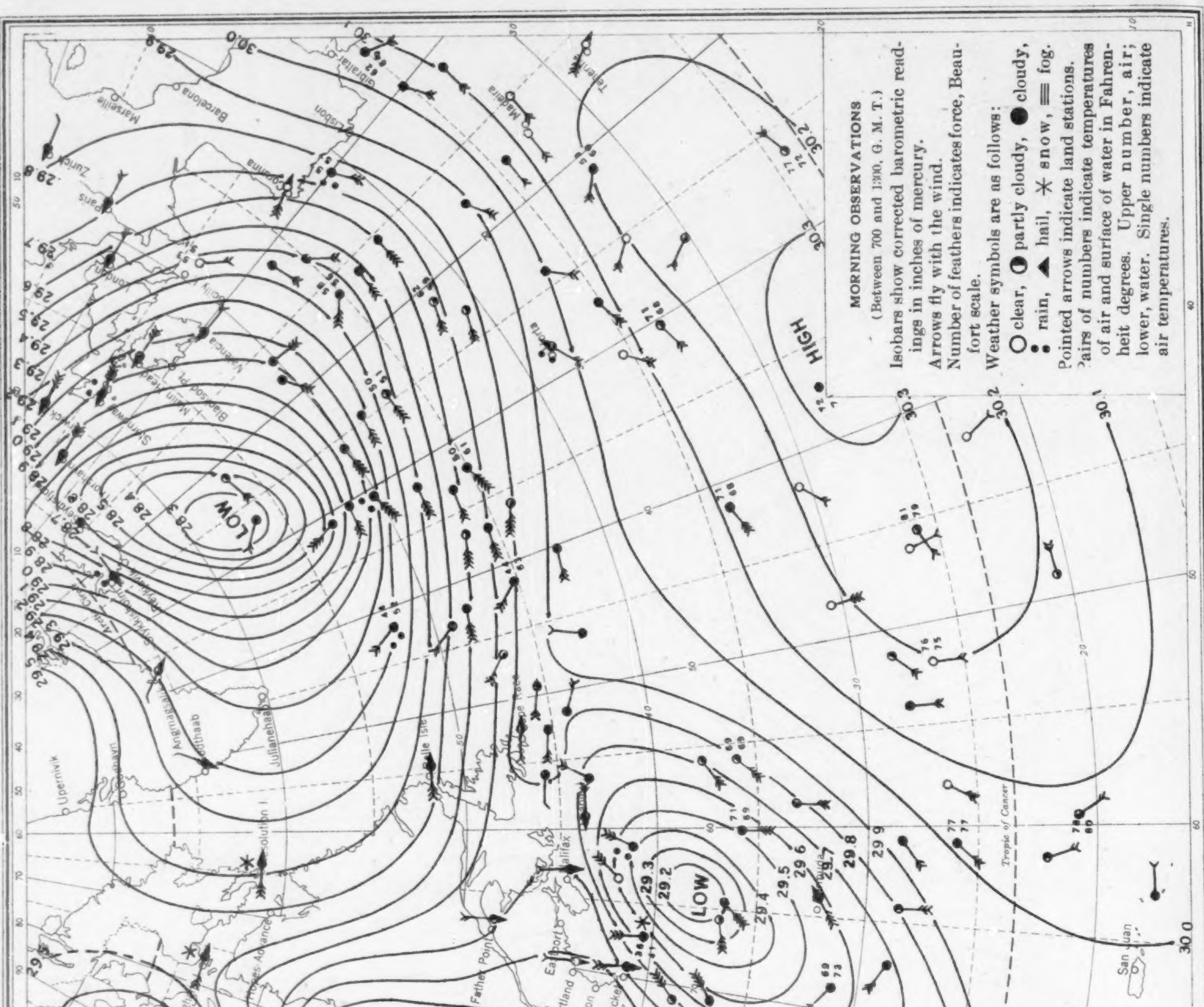


Chart X. Weather Map of North Atlantic Ocean, December 13, 1934
(Plotted from the Weather Bureau Northern Hemisphere Chart)

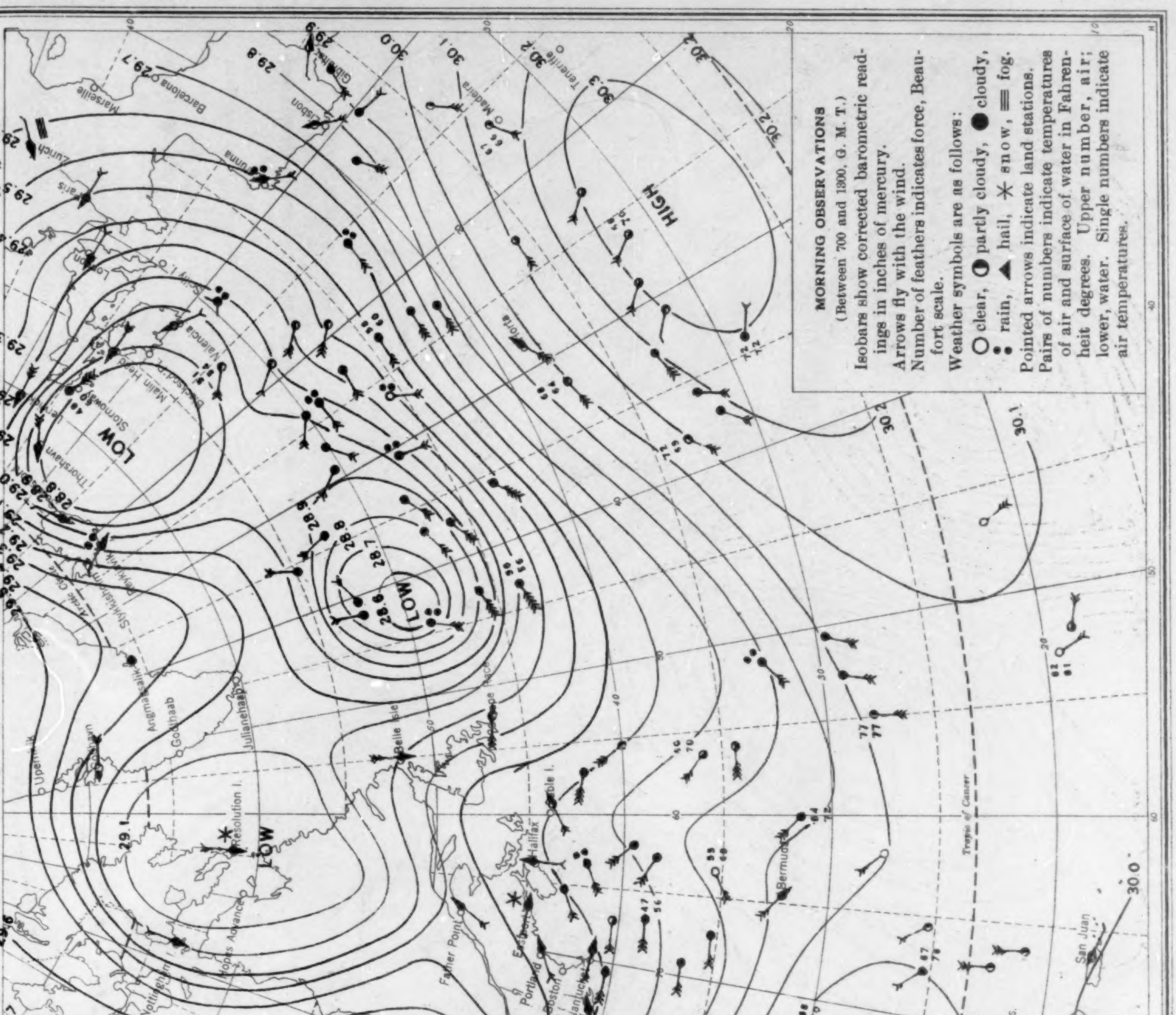
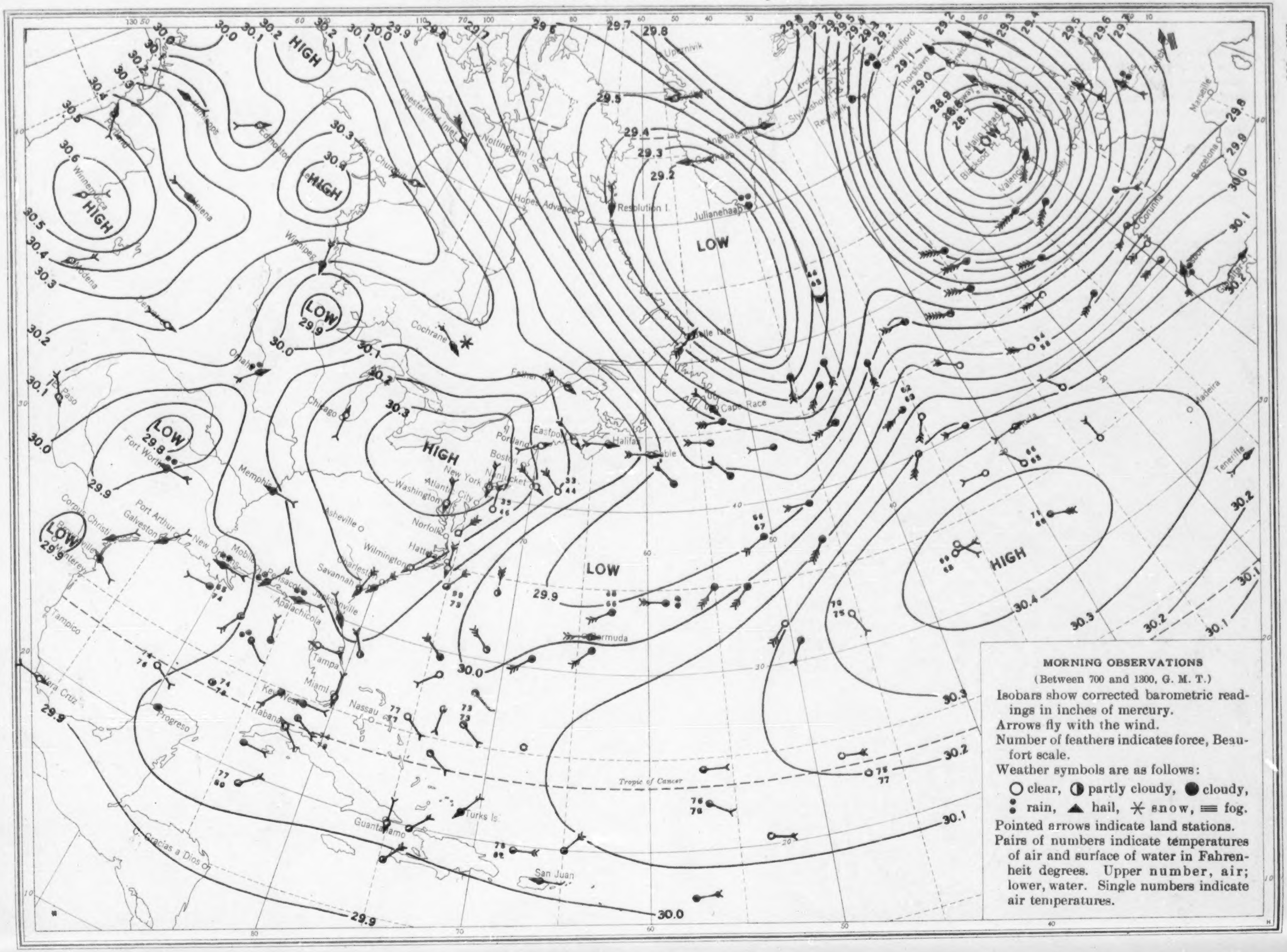


Chart XI. Weather Map of North Atlantic Ocean, December 18, 1934

(Plotted from the Weather Bureau Northern Hemisphere Chart)



MORNING OBSERVATIONS

(Between 700 and 1300, G. M. T.)

Isobars show corrected barometric readings in inches of mercury.

Arrows fly with the wind.

Number of feathers indicates force, Beaufort scale.

Weather symbols are as follows:

○ clear, ◑ partly cloudy, ● cloudy, ⁝ rain, ▲ hail, ✳ snow, ≡ fog.

Pointed arrows indicate land stations.

Pairs of numbers indicate temperatures of air and surface of water in Fahrenheit degrees. Upper number, air; lower, water. Single numbers indicate air temperatures.

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Authors will be expected to prepare their manuscripts with the understanding that once the manuscript leaves the author's hands it is in final form and not subject to further change of text in galley or page proof. With the adoption of this policy it will be necessary that authors consult workers on related subject in other bureaus before finally submitting their manuscripts for publication, and all matters as to which there is difference of opinion must be settled in advance.

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